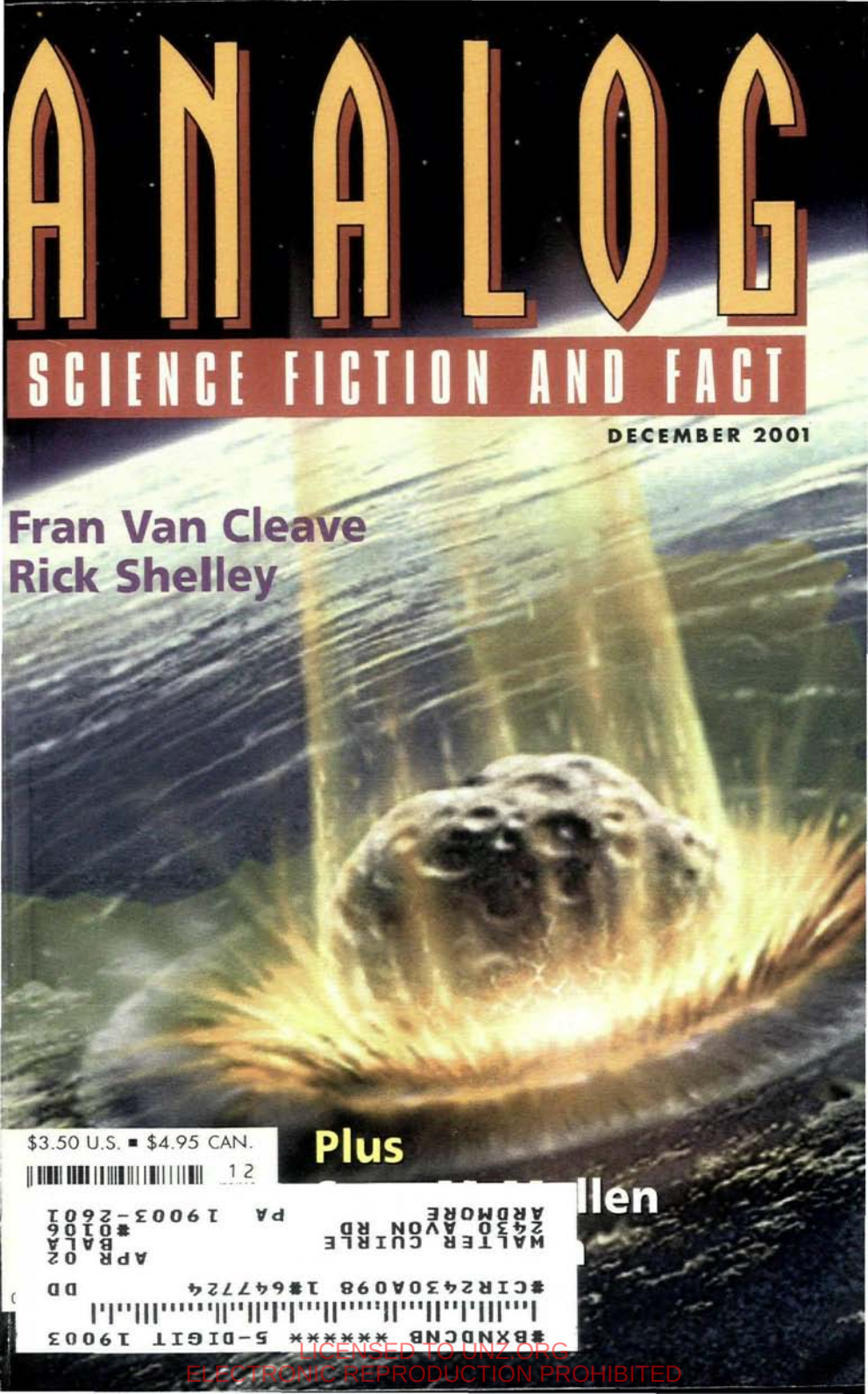
# ANALOG

## SCIENCE FICTION AND FACT

DECEMBER 2001



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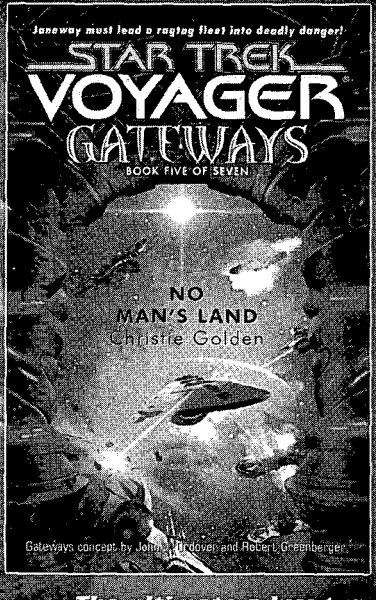


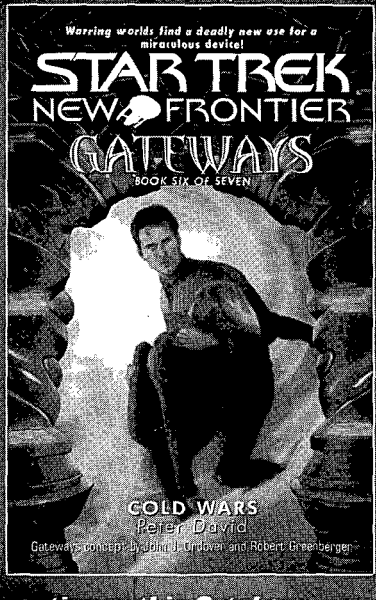
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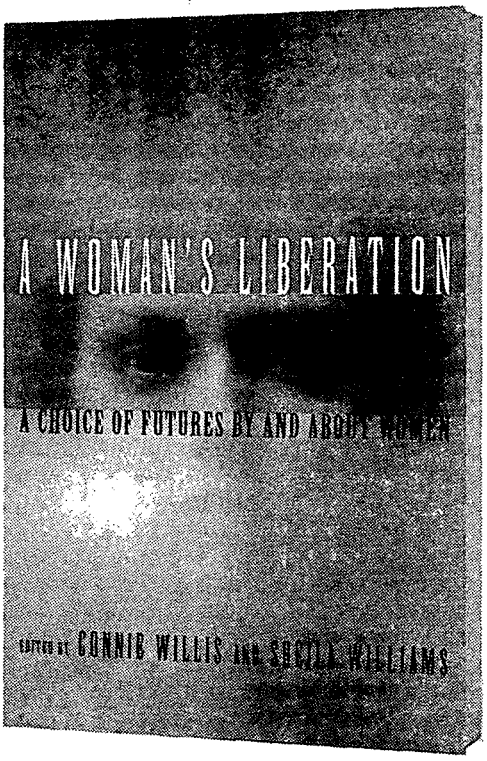


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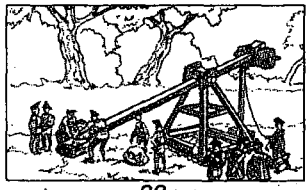

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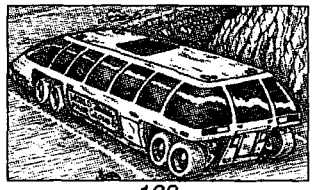

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by Linda Nagata

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# THE HIGH-TECH GOLD RUSH

A lot of people were shocked in late 2000 and early 2001 when, after several years of extraordinarily rapid growth, the stock market—r at least a large piece of it, with a eavy concentration in high technoloy—suddenly turned south. It was a umpy ride, and by the time you read iis, it may have leveled out and perhaps ven resumed its climb. But should anyne really have been shocked at the ownturn anyway?

With hindsight, it seems to me, no ne should have been surprised that the ch stock boom didn't continue indefiitely. It was, after all, a lot like the Calirnia gold rush of the nineteenth cenıry. True, it involved a different kind of re, and therein lies an important differ-ıce; and there were other differences, )o. But there were also important simirities.

In each case, there was a sudden, idespread perception of fortunes to be ıade from a newly-discovered resource ı a frontier: extensive deposits of gold ı the "Wild West" of the past, a huge ıirst for ever newer and better eleconic equipment in our own time. And ı each case there was an intoxicating eling of freedom resulting from the eling that the frontier was wide open ıd established law had not yet figured ut how to regulate it. The result in the ineteenth century was a massive migra-on of all sorts of people to those laces, initially in northern California, here they'd heard that fortunes were ing to be scooped up. The counterpart at the the end of the twentieth and beginning of the twenty-first was a massive migration of entrepreneurs to the manufacture and frantic refinement of computers, cell phones, and so forth; and "dot.coms" and other forms of e-business dedicated to applying the new technologies to other types of commerce.

In both cases, some fortunes *were* made, and a lot of other ventures failed to "pan out." In the original, literal gold rush, the frontier first became so crowded that there simply weren't enough good sites to accommodate everybody who wanted to work them. Then, before too long, the swarms of prospectors simply exhausted the easy pickings. Plenty of gold remained, but it was tucked away in buried deposits, inaccessible without heavy investments of labor and/or money to buy serious mining equipment.

So what happened with the "high-tech gold rush"? Here there was nothing quite so tangible as running out of easily accessible gold. In principle, there was (and is) no end in sight to the technological innovations that were possible. But there were other factors, at least one of which, though I haven't heard much mention of it, *is* at least subtly analogous to running out of surface gold.

We've all heard some explanations, of the sort routinely offered by economists. Will Rogers once said something like, "I

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than the economists, and Lord knows *they* don't understand it." But some of them do sometimes get it right. I can't argue when they point out that stock markets have always alternated between periods of growth and recession, and that the market couldn't possibly support that many computer manufacturers or dot.coms because there wasn't enough total market to give each of them a viable share. Those statements are pretty clearly true, and pretty clearly part of the story. But they're not the whole story.

The part I hardly ever hear anybody mention is that much of the "gold" in our recent gold rush was entirely man-made. Worse yet, it was uniquely insubstantial: it was not a physical material, but an artificially created desire born of suddenly perceived possibilities and fanned by an advertising mentality. There was a lot of money to be made by selling new computers and peripherals and cell phones because, at least for a while, manufacturers had consumers brainwashed into thinking they *had* to buy new computers and cell phones every couple of years—and now, I think, consumers are getting tired of that. The abundance of "gold" depended crucially on a widespread epidemic of what David Pogue and Joseph Schorr, authors of that exceedingly useful tome *Macworld Mac Secrets*, call LAGS (Latest and Greatest Syndrome). And when the LAGS epidemic began to fade, so did the "gold."

Much of history suggests that most people are inherently fairly resistant to change, though occasionally innovation becomes a fad. We've been in one of those periods for some time, when people were drunk on novelty for novelty's sake. I recently heard an electronics executive comment that we "needed" some new audio format that he was pushing because we hadn't had one for a few years. That does *not* prove we need one. It's a real tribute to the vinyl LP that it was good enough to stay a dominant medium for several decades, and a real convenience for its users that they didn't have to run out and buy all new equipment every few years, and scrap old recordings that couldn't be played on it. That sort of thing can get to be a real nuisance, and I think eventually more and more people were bound to catch on that they didn't need a lot of the innovations they were being sold.

Compact discs caught on enough to largely displace LPs, largely because of their convenience. They're small; they're not vulnerable (like LPs) to surface noise caused by dust and worn needles, or to skipping caused by even light footfalls in the room; they can even be played on a tiny player worn on a jogger's belt. The digital medium makes it unprecedentedly easy to know exactly what you're hearing, or to find a particular part of a recording quickly, to know exactly how much time remains, or to change the order in which parts of a recording are played. I've come to pre-

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fer them for these reasons myself, though when I bought my CD player I also bought a good turntable because I saw no good reason to spend a fortune replacing an extensive collection of LPs with the same stuff in a different format (in which some of it would not even be available).

As far as the sound quality is concerned, I don't believe most people can really tell the difference (unless an LP happens to be dirty or worn). Some of those who *can*, actually prefer LPs. As a practicing musician, I'm very familiar with what live music sounds like, and I've always found it amusing how many people will spend thousands of dollars on a system that *can* sound exactly like a real symphony orchestra, and instead adjust it so it sounds exactly like very expensive electronics. I find the sound of my best LPs and my best CDs quite comparable. I'm sufficiently satisfied with both, and have enough invested in both, that I'm not amused by rumblings that CDs and their players are now, after their quite short tenure to date, about to be phased out and replaced by something still newer. When somebody eager to get more of my money tells me I "need" something new just because I haven't had a major change in a few years, I'm not buying it.

I think a growing number of other people aren't either, in this and other fields—notably those related to computers. The high-tech gold rush has been fueled largely by the willingness of many consumers to buy the line that they "have" to have the fastest possible processor and the biggest possible memory. It's bound to lose steam when they start realizing that they don't. It may impress the Joneses to tell them that you just got a 9-GHz computer, but if all you use it for is word processing, the Joneses may be chiefly impressed by your gullibility. You don't need anything like that speed to do word processing. The slowest word processor you can buy is still so much faster than any human that it will spend most of its time sitting around waiting for you to do something. If enough consumers catch on to that fact, figure out what they actually need, and keep it until their needs increase significantly—well, sales are bound to slow down.

Which is not necessarily a bad thing.

On the other hand, those innovation fads do come along periodically, so we shouldn't expect the bottoming-out to

Continued on page 133

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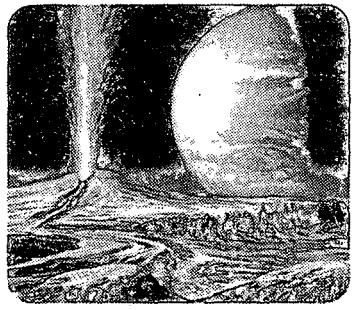

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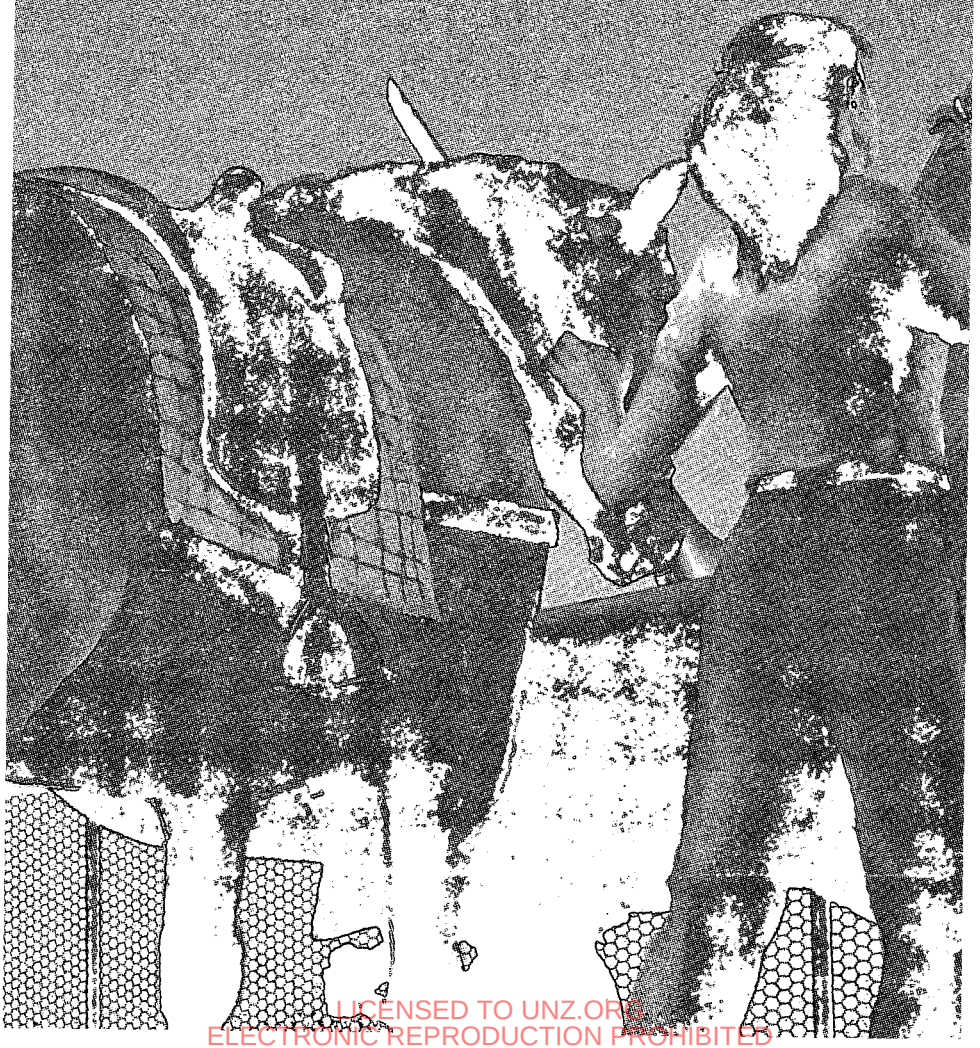
# NAVAJO MOON-BIRD

Fran Van Cleave

*Successful cultures need to be adaptable—but it helps if they can find adaptations that fit their character.*

Illustration by Nicholas Jainschigg



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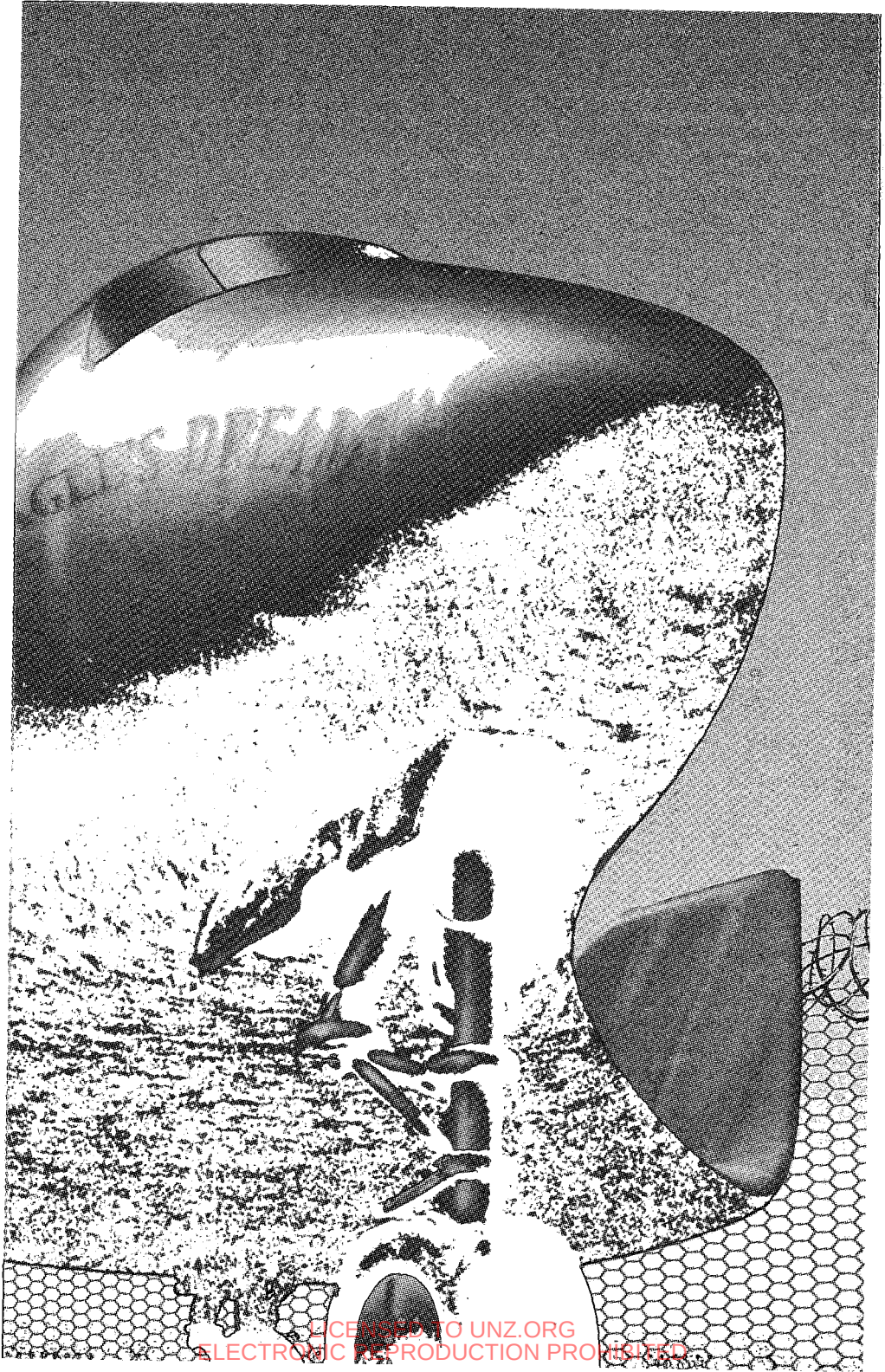

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Day was melting into night as Pandora pulled into the parking lot at Hubbell's Trading Post. Toward Flagstaff, the western sky was all copper and iron-red, like the Earth with the Sun shining through. Due south, over Apache-land, thunderheads smoldered, beautiful but ominous. She hoped it wouldn't rain the night of the contest. Trekking around the Navajo Nation Fair in drenched doeskins was not her idea of fun.

The parking lot gleamed with bumper-stickered Greensafe RVs ("Sterilization: It Works For Your Dog, Why Not For You?") and pastel soda-can cars bristling with body armor and GPS antennas. The snowbirds were migrating early this year.

She squeezed her '98 Chevy pickup into a space and slithered out the passenger-side door. It wasn't worth the trouble to park the old heap across the road.

Her sneakers thumped along the wooden boardwalk; she swung the door to Hubbell's open and walked inside, the air-conditioner immediately plastering her T-shirt to her body. It felt great.

Sure enough, the nineteenth-century trading post was swarming with tourists in crimson "victory" shirts and beribboned bush hats. Every one of them seemed to be lugging an item emblazoned with Kokopelli.

What *was* this fascination with the Hopi fertility god? Did they think his little flute was just the cutest thing?

Digging Mom's list from the pocket of her shorts, she headed for the back, where they kept food staples and household items. Things you could get cheaper at Basha's, or a whole lot cheaper at Wal-Mart, if you wanted to drive twenty-six miles into Window Rock or fifty miles to Gallup.

"Let's see, cotton thread in Rampant Red and Sheerest White. . . ."

Making a left at the wedding pots, she collided with Cameron Roanhorse.

He retreated a pace and started to apologize, then his eyebrows shot up. "Pandora Yazzie?"

"You know any other Pandoras?" Seeing how the coral-colored loose-weave shirt and thin gold watch complemented his mocha-brown skin, she felt hopelessly grubby. He'd always dressed well, but now he looked as if he'd stepped out of the pages of a magazine.

"Hey, look who's grown up!" His grin was a streak of light in his face. "Last time I saw you, you were still in pigtails, but now—whew! What boxes of trouble have you been opening, hmm?"

"Oh, nothing worth mentioning." Actually nothing at all, but she didn't want to sound like a geek.

"Sure." His grin widened, beaming down at her like the Sun itself. Musky aftershave permeated the air between them—something he'd picked up at NAU, she guessed. He shaved even less than most Navajo males—nothing beyond the adolescent milli-moustache invaded the sanctity of his upper lip. "Did you hear about the end-of-summer party I'm having a week from tonight?"

"Yeah, who hasn't?" Another fib.

"You want to come?"

"What, with you?" Pandora felt her knees weakening . . . or maybe it was her brain. Cam had the kind of chiseled features that inspired countless bad verses on dateless Saturday nights, all devoted to the proposition that the gods practiced sculpture on Monument Valley and then made a human male. (As an agnostic, she considered it strictly poetic license.) Plus, his dad was a big wheel on the Tribal Council—he'd barely lost the presidential election. "I can't. I mean, it's impossible."

"Why?"

"Well," she floundered, hardly able to believe that he'd not only asked her out, but persisted in it, "that night's the Miss Navajo contest. I, um, happen to be a contestant."

Around the beginning of summer, she'd suddenly quit being an ugly little owlet, oversized eyes in a stick body,



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and became . . . well, something people enjoyed looking at. She still wasn't used to it.

Cam tilted her chin up with a finger. "I can believe it. Ditch those glasses, and you'll *definitely* win."

An extrovert would have said something light and self-deprecating, and they both would've laughed. But she was at that stage of social ineptitude where serious answers and bald truth are vitally important.

She stepped backwards, bumping against the shelf. "Olivia Jackson should win. She's the stronger candidate."

He shrugged and turned away. "I say you'll win. But maybe you shouldn't come to my desert party. We're having a few beers—your parents won't approve."

"They might." And the Moon could fall out of the sky tomorrow. "But with you in your first year of pre-law, you could get in so much trouble. . . ."

"Do you really think my Dad would let the tribal police waste their time on my little party?" Cam turned back to her, amused. "He's after hard-core bootleggers, the ones who haul it up by the truckload from. . . ."

"Kid, is he bothering you?"

Pandora's head jerked like a startled deer. An Anglo stood less than two yards away, looking at her as if expecting an answer.

His eyes were the deep gray of hematite, his skin burnt dark as Cam's. Actually, his face reminded her of sandstone, layers of tan graduating to brown: the trim beard a shade darker than the face, both darker than the short military-cut that stuck out from beneath a crisp white head-bandage. The plainness of his face was exaggerated by his sky-blue baseball cap, which sported a flaming silver rocket encircled with "Selene Development, Inc." in sixty-point Copperplate.

Had he just got out of Sage Hospital? It was only a mile from here, up 264.

Cam squared his shoulders. "We're having a private conversation." Scorn dripped from every syllable. "Do you mind?"

Gray Eyes ignored him. "That how you read it?" He was scarcely taller than she, but lean and compact. Thin lines fanned from his eyes and mouth. She'd thought him twenty-five at first; he might have been thirty.

"Precisely," she replied frostily. Kid, indeed! Did he think she was some helpless subadult in need of rescue? If he started a fight with Cam, she'd call the police!

The Anglo nodded, more amiably than she expected. "Sorry to bother you. Let me at that coffee, and I'll be out of your way."

"Help yourself," Pandora said. It took her a second to realize she was still pressed up against the coffee shelf. "Sorry," she said, sidestepping.

"You don't have to apologize to that arrogant pig," Cam said in Navajo.

Gray Eyes helped himself to a five-pound bag of Rivera tortillas, the biggest jar of Folger's, and a pint of Tabasco, then strolled up to the cash register with a stride that was easy but energetic—you didn't see too much of that around the Four Corners area, especially not since the war. You could practically see the heat boiling off him and reforming into his own personal bombshells, which he could then expend on seemingly immovable objects.

"Who is he?" Pandora whispered.

Cam snorted. "A crazy *biligaana*. He and Jack Yazzie paid the Tribal Council umpty-thousand *besos* to fly a scrapped bomber to the Moon from Window Rock airport. I'd be worried if I thought the damn thing would ever get off the ground."

The idea was *tsih*, but Pandora had always been fascinated by such madness. The news stories online said they planned to build a city inside lava tubes on the Moon.

"It will if Jack's flying it," she said. "He could fly a grizzly bear to the Moon."



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This fellow must be either a former Air Force buddy, or the millionaire backer. The stranger's rough-and-tumble look argued against the latter interpretation.

". . . Yazzie's all balls and no brain. Why do you keep looking at that Anglo? You like his ass or what?"

"What?" She glanced at Cam. Was he actually *jealous?* "Don't be silly."

"Say you'll think about coming to the party with me," he said. "After the contest?"

The stranger finished paying for his stuff and strode out the door. As he exited, he caught her eye and winked. Annoying—as if he'd had the last word, a cynical one.

"I'll think about it," she said. Cam's dazzling smile made her feel more glamorous than Changing Woman.

"Good girl. How 'bout I call you in a few days?"

"Sure." Mom and Dad would have a fit if they knew she was thinking about sneaking out to the desert to party with a college boy. She'd have to slip out the window, and she'd never done that before—it wasn't like her. Or was it? Was it only because no one had ever asked?

"Great!" Cam brushed his fingertips against her wrist. The tingle went all the way to the roots of her hair.

She smiled back like a cigar-store Indian, wondering how she could possibly hide this from Mom and Dad.

"What's *with* you, Dora?" Olivia demanded. "You never want to go riding. Now you do, and it's not even good weather. We should've gone this morning."

Pandora glanced upward. With one lone turkey buzzard riding the thermals, the turquoise sky seemed a million times bigger and hotter and emptier than the desert around them. The Sun burned through her Wranglers like a branding iron.

"I had to hem dresses this morning. And I will bet money that Mom ripped out my seams after I left."

They were several miles southeast of Olivia's hogan, which was northwest of St. Michaels, halfway to Cross Canyon. Actually, it was her grandmother's hogan—she took Olivia in after her father went back to Chicago and her mother died from tuberculosis and a broken heart. People say a skinwalker killed her. Hardly anybody on the Rez believed in accidents.

Olivia shook her head, making her silver earrings tremble. She had a fantastically exotic face: huge coal-black eyes, cheekbones Varushka would kill for, perfect Nubian-bronze skin. "She'll never give up trying to make you into Susie Chee Homemaker."

"It was my idea. I felt guilty about how hard she's been working. I also feel guilty about competing against you."

"Well, don't."

"I can't help it. You cook and sew better than I do, you make your own jewelry, you speak Navajo better. . . ."

"But I'm half-black," Olivia smiled. "An Afrajo. And I look it."

It made Pandora mad all over again, thinking about some of the letters she'd seen in *The Nava-Hopi Observer*. "You look Navajo, too. Even if you weren't gorgeous, you still deserve to win."

"Thank you. Don't you dare drop out, or I'm really going to be sore at you."

"I'm not." Pandora patted her horse's neck. The mare's ears rotated like radio antennae, scanning for a signal to return to her corral with its tiny patch of shade. She was sweating in rivulets.

"Good."

"Cam Roanhorse asked me to go to a desert party."

Olivia sucked in her breath. "What'd you say?"

"That I'd think about it."

Olivia gave her her patented flinty-eyed glance. "You listen to me, girlfriend. You got dust devils in your brain if you go out in the desert with him. He wants one thing, and one thing only."

"Don't be so negative, Livvy. I think he's desperate for someone intelligent,



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someone who can speak to him on his own level."

"Intellectual companionship?" Olivia snorted. "Gimme a break. Girls have sex to get love. Boys pretend love to get sex. Put that together and what does it spell? Broken heart. And for what? A pretty boy who's not as smart as you are. Who needs it?"

Who needs this simplistic analysis? Luckily, Pandora caught herself before speaking—that was what'd happened to Olivia's mother. It couldn't happen to *her*.

Olivia stared at the horizon, which trembled as if viewed through a flame. "You've got to see the world, Dora. Fly as high as you can! Just remember, eagle dreams take strength."

"And money. NAU isn't cheap."

"You could get an academic scholarship."

"There's lots smarter girls out there trying to dodge the draft." Pandora shaded her eyes with a hand. She wouldn't take a pregnancy deferment for a case of immaculate conception—after baby-sitting four brothers all her life, she preferred field-stripping machine guns to changing another diaper. But she *wanted* that college deferment. "Hey, there's the airport! Since Jack's your clan grandson, you suppose you could. . . ."

". . . introduce you?" Olivia finished. "There's another one who won't be sitting by the campfire telling tales about the Blue Flint Boys while he waits on you."

"I want to see the rocket. I'm no warhero groupie, you know."

"I know." Grinning, Olivia touched her moccasined heels to her buckskin gelding. "We can always say we were just riding by."

They halted the horses on the south side of the airport.

At least fifty people were swarming around something parked in front of the west-side hangars. Its sun-bright windscreen hurt Pandora's eyes, in contrast to the rest of it, which was constructed of some anonymous-looking gray-black metal that blended into the asphalt runway. By comparison, the little aluminum Cessnas looked like Christmas ornaments.

Like everyone else, she'd read plenty of news articles about the B-7 Black Ghost—launch from California, up into space, and thirty-five minutes later bomb the crap out of the PLA—but few people outside the Air Force had ever seen one. Classified, you know, and now all of a sudden it wasn't.

She pulled off her neckerchief and blotted her sweaty forehead. She could hear banging and hammering and the whine of an electric saw, like a mosquito dive-bombing her ears.

The mare uttered a disgusted snort and dropped her head, questing for grass amid the snakeweed.

"They look busy," Olivia observed.

"Yeah." They were doing complicated, probably dangerous work. They wouldn't appreciate an interruption from a couple of nosy Native American brats.

Just then a boy came out of the nearest hangar. He did a double-take and trotted toward them. He looked to be around fifteen; his short, bristle-brush black hair and round face marked him clearly as Navajo.

"Isn't that Melvin Begay?" Olivia said.

"Uh-huh." The only person at Ganado High who was a bigger nerd than Pandora. Mel had been beaten up a lot for being "too smart." Pandora had been in the same boat, but after she explained things to the biggest bully in terms he could understand, the gang left in search of more pliant victims. But she was taller than Mel, and it was a lucky punch.

Mel halted a little ways from the fence, hands on his chubby hips, clouds of caliche dust settling on his Keds. "*Yah-aat-eeh*." But he was frowning at them through his thick glasses.

"*Yah-deh*," Olivia and Pandora



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replied.

"What's up?"

"We want to see the bomber up close," Pandora said brightly.

His forehead furrowed. "They're pretty busy."

"Too busy to see job applicants?" Pandora said. She didn't know where that came from—it just popped out. Sometimes her mouth moved faster than her brain.

Mel sighed. "Really, Pandora, I hardly think yours are the appropriate skills for this situation. You might turn the wrong knob and blow the place up."

Pandora gave him a dirty look. "Worried about competition, are you?"

"Not at all. Take-off's next Saturday at sunrise. Come back then."

Olivia turned her melting smile on him. "Can we water the horses here?"

"Sure. Say, Olivia, you look really nice today!"

"Thanks."

He did something with a gadget on his belt, then unhooked the gate. "There's a bucket by the hangar, and plenty of running water. Just don't get in anybody's way."

"*Hagoshee*," Olivia acknowledged, glancing at Pandora as if to say: That's how you handle men.

"*Aoo*," Mel beamed, swinging the gate wide.

Pandora nudged the mare and she trotted through the gate, tossing her head. Mel was lucky she didn't ride right over him.

Inside, they dismounted and led the horses toward the hangar, the horses' hooves ringing a contrapuntal melody on the asphalt.

Pandora couldn't take her eyes off the ship. It grew bigger with every step.

It had the jutting nose of a fighter—an eagle's beak with the tip filed down. The wings were regular deltas with the leading edge angled inward halfway back, the tips bent up ninety degrees. Maybe sixty feet long by forty wide, and even with all the dents and dings, and that incredibly dull military paint job sucking up light instead of reflecting it. . . .

It was magnificent.

As they passed the curving overhang of its belly, through the yawning bomb-bay Pandora saw a woman working on something, her long blonde hair pulled back in a pony-tail. Outside, men went this way and that with tools and buckets of paint; several were sanding the dents and dings. Everywhere was the feeling of purposefulness and energy Pandora had sensed from the Anglo in Hubbell's.

About a third of the men were Navajo, a few Apache; she recognized maybe half. She and Olivia received a number of surprised looks, which they grandly ignored.

They reached the hangar, and Olivia had just started filling the bucket when Pandora heard a man's voice say, "What the hell are those two *jin-jas* doing here?"

*Jin-ja* was vet's slang for women, "*jin*" being Chinese for gold.

Jack O'Brian Yazzie was heading right for them, followed by a half-dozen Navajo boys. Pandora had seen him only a couple of times before he volunteered for the Pan-Asia War—he'd grown up herding sheep at the bottom of Canyon de Chelly—but NetNews had made his face as familiar as her own.

Picture eyes the tawny color of the San Francisco Peaks in summer. Add a go-to-hell grin in a fine-boned Navajo face, an Irish nose inherited from his grandfather, homely as a potato, and straight black hair seething over a high forehead. That was Jack, but of course holos couldn't capture the man's intensity.

"Who let them in without notifying security?"

Mel hung his head. "I'm sorry, Jack. I did. They needed to water their horses."

The gelding slurped water greedily. Olivia pulled the bucket away to keep him from making himself sick, gazing at the irate war hero through her long black eyelashes. "Grandson, don't you



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recognize me?"

Jack looked baffled for an instant, then clapped a hand to his forehead and groaned. "I'll be damned! Grandma Livvy! How'd you grow up so fast?"

"Couldn't help it. I was fourteen when you left." Olivia hugged him. "Jack, this is my best friend, Pandora Yazzie."

"Nice to meet you, Pandora." He shook her hand. In spite of the chocolate-brown freckles scattered across the bridge of his nose and a charmingly crooked smile, he looked *way* older than twenty-three. *Wars will do that to you*, Pandora supposed.

"Nice to meet you, too." She thought him arrogant and hot-tempered.

"Jack!" somebody yelled from inside the hangar. "What's the deal with these gaskets? Do we trash 'em or not?"

"Well, girls, it's been fun, but I gotta get back to work. Have Mel let you out." Followed by his fan club, Jack disappeared inside the hangar, his voice echoing off the steel walls. "If you morons think I'm gonna fly this bird with those piece-of-shit gaskets, you are out of your fucking minds!"

Romantic war heroes, Pandora decided, are best left to poets. With good editors.

She filled the bucket with water for the mare, who snorted happily and plunged her muzzle in with a splash. Olivia gave Pandora a speaking look. She wouldn't talk with Mel hanging around making sheep's eyes at her.

Somebody jumped down the ladder from the bomb-bay and approached them. It was Gray Eyes from Hubbell's. His white T-shirt and jeans were as filthy with dust as his head-bandage, and he had a pair of welder's goggles pushed up on his forehead. "Mel, have you seen my Vise-Grip?"

Mel blushed. "Uh-huh." He vanished into the hangar.

The man grinned cheerfully. "*Yahaat-eeh*, ladies." He shook hands, not in that exuberant way that Anglos often do, but more formally. "Dan Mallory, at your service."

His diction was crisp, his baritone voice like the rumbling of a distant waterfall—Pandora hadn't noticed it last night—which contrasted oddly with the calluses on his hands. She liked it that he didn't stare at either of them. It couldn't be every day he saw a gorgeous Afrajo girl come riding up, her kinky hair tied back in a Navajo roll.

Pandora introduced them, including Olivia's relationship to Jack. Mallory didn't blink at her name, but she marked the appearance of a tiny frown line in the suntanned skin between those unruly dark eyebrows. Did he remember her? Or was it only Jack and Olivia's clan relationship, which Anglos found impossibly confusing?

"Here's your Vise-Grip, Dan." Mel's eyes darted sideways at Pandora as he emerged from the hangar. He clearly regretted inviting them in. Maybe now that he finally had some friends, he didn't want to share.

"Thanks."

Olivia dimpled. "Pandora wants a job. She knows everything about computers."

"Not true," Pandora said modestly. "Nobody knows *everything*."

"We're A-OK with the computers," Mallory said, lighting a cigarette. "What we really need is a cook. But I don't suppose a smart young lady like yourself would want a dirty job like that." He exhaled smoke. "Anyhow, you probably can't cook."

Pandora stared at him. "What do you mean by that?"

"Generally speaking, women inclined toward technical work can't cook. And that goes double for lookers. Leslie's like that—can't boil water without burning it, even at this altitude."

The nerve of this creep!

"It so happens," Pandora said stiffly, "that I am an excellent cook."

This was embellishing the truth, but Olivia didn't give her away. What did



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Pandora care? She didn't want to cook for him.

The idea was ridiculous, anyway. Dad would never let her work here. The very idea of her hanging out with strange Anglo men would be vetoed by Mom faster than a desert party with Cam Roanhorse. Cam's wealthy dad could win her over eventually.

Mallory gazed up at the ship, the cigarette hanging from the corner of his wide mouth. "I don't know why I bothered to bring it up. This camp's no place for a woman."

"A woman's inside the ship right now," Pandora observed.

"Leslie, yeah. But she's not like most women—more like a man. On steroids."

Scowling, Pandora folded her arms. "Any place men go, women should go, too."

"A sentiment I'm usually more than happy to agree with. However, other countries are rushing to settle the Moon. Depending on how they go about it, things could get uncomfortable around here." He studied her unchanged expression through a nimbus of cigarette smoke, then said in perfect Navajo, "What do you think of taking a spaceship to the Moon? Is space not the realm of the gods?"

Of course, Navajo has no word for "spaceship"; he used *chi'deh n'ahaheh*, which meant flying machine.

He understood everything Cam said back at Hubbell's—no wonder he'd winked!

Pandora recovered from her shock in a few seconds and replied haughtily, "If the gods *really* didn't want people to go there, nobody would ever survive the trip. If you can fly to the Moon in this, *nizhoni*."

His teeth showed white against his beard. "She is beautiful, isn't she?"

Olivia beamed. "This is so thrilling. You guys are gonna put Window Rock on the map. Can I have a job, too?"

Mallory dropped his cigarette on the ground and stepped on it. "We launch next Saturday. That's not much time."

"That's OK. We cook good, you pay good. We don't cook anything, you pay us nothing."

"Deal."

The first thing Mallory did after showing them the kitchen trailer and where to document their hours was introduce them to the head geek, a big-nosed blond software specialist named Henry Ten Eyck. He gave Pandora their e-mail address and said she could help with the computers if a problem arose.

It wouldn't, of course. All the hardware and software had already been installed, the systems debugged by people much smarter than Pandora Yazzie. She recognized the offer as your basic carrot, intended to keep her hopes up so she wouldn't run out of the kitchen in a day or two, screaming like a maniac.

Since they were currently bug-free, Henry did the cooking, though he freely admitted to being so bad that the crew had started ordering from Taco Bell and Blimpie. As the men grew hungrier waiting for the food to arrive, work on the ship slowed. This had disturbed Jack greatly and inspired one of his infamous tirades.

After inventorying supplies in the kitchen trailer, Pandora and Olivia decided to make Navajo tacos and coffee for supper.

"Coffee?" said Henry. "I won't be able to sleep if I have coffee for supper."

Pandora was surprised to hear a man admit to a physical inability. "I thought you wanted us to get more work out of these guys?"

Olivia laughed at Henry's expression. "Don't worry, we'll make decaffeinated tea for you."

Mike "Tinkerbell" Pulaski, a cheerful behemoth with white-blond hair who probably didn't weigh quite as much as Shiprock, took it upon himself to explain the importance of meeting next Saturday's deadline.

"Once every twenty-eight days, Earth



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and the Moon are positioned so that any ship leaving then will have the easiest possible path to the Moon. That means it burns minimum fuel and carries maximum cargo. We *have* to carry the max, so if we don't make this month's launch window, we'll have to wait 'til next month.

"The better fed the crew, the faster they'll work, and the more likely it is we'll be ready. You girls can really help."

Pandora sprinkled cumin on the hamburger and lowered the heat. "Why do you have to carry so much cargo?"

"Didn't Jack tell you this is the first Moon settlement? That he's one of the colonists?"

"No, but I read about it. I also read that the backer sent a whole shipful of stuff already, and it's waiting for them on the Moon."

Pulaski looked at her, his swollen left eye sporting more colors than an Arizona sunset. Which of these men was tough enough to hit someone his size? Dan or Jack?

"They launched a heavy-lift booster with forty metric tons of supplies, that's true," he said. "But it's mostly air and water, the lunar habitat, and mining tools. A colony needs everything they can't make, plus regular deliveries of food 'til they can get a farm going."

Olivia gave her palm-sized piece of bread dough a final pat and tossed it in the fryer. "They should take fry bread along. Breakfast of champions!"

Sniffing appreciatively, Henry watched the dough expand in the hot oil. "They won't have much time to cook for the next decade or so."

Pandora was still thinking about the rocket. "They'll have to bring their fuel for the return trip, won't they? Or will they send another booster?"

"Launch pad time is pretty hard to come by right now," Pulaski replied. "That's one of the reasons we're here. Our guys'll bring all their return fuel with them—they just can't lift it off the ground. We've got another pilot flying an old Air Force stratotanker out of the airport in Gallup. He'll rendezvous with our guys at 43,000 feet and refuel 'em."

She imagined a gas pump sitting atop a cloud. "How will he do that?"

He grinned, delighted by her interest. "Boom system. The pilots have to cooperate, but they can transfer 1,200 gallons a minute."

She pictured the two planes stuck together like a couple of mating hummingbirds, and burst out laughing.

Olivia laughed until tears came to her eyes, and she almost burned the fry bread.

Henry carefully explained that this was the only way a spaceplane burning jet fuel and hydrogen peroxide—the least expensive and most environmentally benign rocket fuel—could fly to the Moon and back. Otherwise the fuel tanks would be so big and heavy, it'd never make it into orbit, let alone carry cargo.

When he put it that way, the aerial refueling seemed a cleverness worthy of Coyote. Pandora wished she could see it. Could she slip out to Cam's party, come home and then skip off to the airport? Suppose she zeroed Cam's party and went to the launch instead?

Her parents would say: "It might blow up." She'd point out that only one Black Ghost had exploded on take-off during the entire Pan-Asia War, and they'd argue about it, and she still wouldn't get to go.

Pandora would just have to think of another way.

Pandora and Olivia returned to the hogan Olivia shared with her grandmother about an hour before sunset.

Mexican pinto beans simmering over the fire mixed with sweet arid perfume of mesquite to form a delightful aroma. Pandora was glad she'd eaten a couple of Navajo tacos, so she wouldn't be drooling over Olivia and Nanabah's humble dinner.

Sheep "baa"ed in the distance. Pando-



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ra could see a herd coming, and a green-clad figure that was probably Nanabah.

A truck appeared to the left of the herd. At first Pandora thought it had backfired, but then she saw the rifle barrel sticking out the window. Someone had fired a shot!

The sheep ran everywhere, "baa"ing in high, frantic voices—except for one, which spun around in circles, shrieking madly.

Everything seemed to happen at once. Waving her arms and shouting, Nanabah hurried toward the injured sheep. Three teenage boys jumped out of the truck and tried to drag the sheep into the back of the pickup. Olivia's sheepdog flung himself on the nearest boy just as Olivia came charging out of the hogan with her Remington.

Another gunshot popped and Nanabah fell.

Olivia aimed the deer rifle and fired. A window shattered in the truck, and the boys sprang back inside faster than lizards. The engine roared, and the truck tore off in a hailstorm of pebbles.

Olivia ran to her grandmother, Pandora right beside her. "Nanabah! Are you all right?"

The old woman got to her feet, brushing herself off. "Of course I am all right. I hit dirt. Only crazy person stands like target."

"Thank God you're OK!" Pandora said shakily. She could imagine how Olivia felt at the prospect of losing her grandmother over a sheep.

Olivia was pale and angry. "Next time, Grandmother, don't run at them."

"Bah! These gangs, they're all cowards with whirlwinds in their heads. If they had asked for food, I would've given it to them. What Navajo would not?"

"I didn't recognize them," Pandora said.

Nanabah shrugged. "Young people all look alike to me now. My eyesight is not what it was."

"I don't know them, either," Olivia said grimly. "But I bet they were surprised to find women with teeth."

"Where's Dog?"

"Over there," Pandora said. "I think he's hurt."

The three women rushed over to him. He lay on his side in the dust, bright blood dyeing his yellow fur. His tail thumped a couple of times, feebly.

Nanabah bent down and examined the wound. "His shoulder's not broken. The bullet go right through him, pretty high. We save him, maybe."

The wounded sheep was already dead. Grandmother decided to butcher it before the heat ruined the meat.

Olivia ran to fetch water, a blanket, and bandages. Pandora hopped back on the mare and rounded up the remaining sheep. By the time she'd chased the last one in the corral and barred the gate, which was so rickety it looked as if it'd fall over in the next breeze, Olivia had carried the dog to the shade of the spreading mesquite tree.

He yelped only once, when Olivia put him down.

Nanabah sat cross-legged as she washed his wound, a little old woman wearing a squash-blossom necklace dating from the time of Cortez with a lime-green polyester blouse and Ganado-red skirt, her pipestem arms freighted with the products of Zuni silversmiths. The toes of her Nikes stuck out from beneath her skirt-ruffles like round blue mushrooms.

"Turquoise Girl tells me you went to see the machines that fly."

"Yes, Grandmother, that's right." Pandora seated herself near the loom, its partially woven rug depicting a *Yei-bechei*, a god that to Anglos resembles a Hopi *kachina*.

Olivia brought the dog a bowl of water, and he licked her hand. He didn't have a name; the Navajo weren't sentimental about their animals. They couldn't afford to be. But from the sadness in her friend's eyes, Pandora thought she would miss more than his shepherding ability if he died.



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"And you yourself saw this new machine?" Nanabah persisted. "The one that flies to the Moon?"

"I saw it. It is like other flying machines as the eagle to a cactus wren."

Grandmother's brown eyes were bright as brook pebbles in her leathery face. "It was bound to happen. I have seen much change over my lifetime, things that would never have been believed when I was a girl."

Pandora thought that for those born in 1910—or thereabouts, nobody kept track of birthdays then—these gangs of predatory boys must be a shock. Nobody knew why the gangs had formed, though the school psychologists talked knowingly about "dysfunctional homes" and most people blamed the Anglo TV.

". . . people of change," Nanabah muttered.

"The whites?"

"The *Diné* . . . we have change in our blood." The old woman cackled at the expression on Pandora's face. Nanabah knew her opinions; they'd had enough discussions about it. "Only think on it, child. Five centuries ago we left Grandma's Land"—old-time term for Canada—"and fought the Hopi and the Pueblo for this ground. We settled here, but not in boxed-up cities like theirs; we roamed still. Then the Spanish came, and from them we got our horses and began herding sheep. From the whites we picked up cattle and flour and sugar . . . and much worse things. It's gone downhill ever since."

"This is the first I've heard you tell that story," Olivia said.

Nanabah shrugged. "I got it from an Apache."

Pandora watched her spread Bacitracin and sage on the dog's wound. "Aren't modern medicine, books, and the Net worth the bad things?"

Smiling, Grandmother pinched her cheek. Nanabah placed stories about the Net in the same category as stories about the Heavenly Twins leading the people to a better life. "Change must balance. We must walk in beauty between the old ways and the new."

Next morning Pandora found Dad wide awake on the sofa in his old purple bathrobe and slippers, watching TV, reading the Sunday paper and drinking coffee. This despite returning at dawn from the peyote meeting. *How does he do it?*

Dad frowned down at his paper. "It says here that the Chinese shot down Jack Yazzie five times, twice with a satellite."

"Jack's a hero!" Tash piped up. "Daddy, can we play mushroom-cloud?"

"No, son, I don't want you playing that game."

"Jack was captured by the PLA the last time," Pandora said. "He escaped."

Dad rattled the paper. "If he had any brains, he'd consider it a warning. Space is the realm of the gods; men are not supposed to go there. He's lucky he wasn't killed."

She groaned inwardly. *No wonder the Tribal Council outlawed peyote! If the stupid U.S. government hadn't stepped in and told them to stop interfering with freedom of religion, I wouldn't have to listen to this crazy talk.*

Mom cracked eggs into the frying pan. "Pandora, what're you doing up so early?"

"Well, since school starts tomorrow, I thought I'd get the laundry done early, then have the rest of the day to myself."

Mom eyed her as if the maternal radar was already pinging with the news that her daughter was up to something. "I need your help making tortillas this afternoon. And you should try on your blouse and skirt for the final fitting."

"I'll be back in time, I promise."

Mom stirred the eggs. She looked like those old pictures of Sophia Loren in her thirties. She had a mole on her cheek, and her wavy black hair was brown where the Sun bleached it. "There's enough material left to make another skirt—an everyday one."



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Hope springs eternal.

"You've already made too many," Pandora said. "You work all day and sew all night. You don't need to do any more."

"So you'll make the everyday skirt?"

*Me and my big mouth.* "Um, I'd better go before the washing machines are all taken." Grabbing the laundry basket, Pandora zipped out through the living room, jingling the truck keys as she jumped over Tash's rocking horse.

"Don't be long, little one," Dad said from the sofa. "I've got to pick up firewood this afternoon. I'll need the truck."

"OK."

Dad turned around. "Drive carefully. No speeding."

"I never speed, Dad."

"You are in one big hurry for someone who never speeds. Don't you have a hug for your old *Shizhe'e?*"

"Yeah." Pandora dashed back and hugged him, breathing in the sharp sweetness of cedar and sage from the medicine bag around his neck. On the TV, the Discovery Channel logo segued into President Bluehouse's face.

"That weasel," Dad said as he flipped the channel. He had one of the three typical Navaho faces: high cheekbones, round cheeks, slightly tilted dark eyes that always look like he's smiling, even when he's sad. "What's this world coming to when they elect a Christian as Tribal President?"

Pandora didn't dare mention the rumors of his agnosticism. She dragged the laundry basket out onto the front steps, only to be stampeded by Gil, Rob, and Lionel.

"Dad!" Gil shouted. "Mr. Tsosie says me and Rob are the best barrel-racing team he's ever seen!"

"For your age," Lionel corrected. The youngest of the three, he was taller and wider than his brothers. "I'm the best bull-rider. Dad, can't we get our own horses for the rodeo?"

Her brothers: fifteen, fourteen, and thirteen, respectively, and if it didn't have four legs, they weren't interested. They wore belt buckles as big as their heads and chewed Copenhagen behind Dad's back.

"We don't have anyplace to keep them, son. There's no barns in this housing project. But maybe we can ask the Tribal Council to. . . ."

Pandora slammed the door, threw the laundry in the back of their Chevy, jumped in, started it and backed out, squeaking past the dented front fender of the neighbor's Dodge with a millimeter to spare.

Calf-roping and barrel-racing! Ask the Tribal Council to *let* us have a horse-barn!

She felt like screaming. This is 2012, not 1812! What do we gain by doing the fly-in-amber routine? Real sovereignty from the U.S. government? Snowballs stand a better chance of growing permafrost hairdos in Lake Havasu City.

The only other person at *Tse Bonito* Laundromat was old Alice Yellowhair, who always sat through the whole cycle so no one would steal her laundry. She promised to keep an eye on Pandora's.

Jamming half a roll of copper war-dollars in the washers' coin slots, Pandora hurried back out to the truck. It was one of those chill high-desert dawns, with the sky a million miles of blue and the wind flinging arrows of sand. Today was going to be another scorcher.

A five-minute drive brought her to the turn-off at the blue airport sign. Just after the bridge, she saw a shiny new red-and-silver SUV pull into the desert. The driver looked like Jimmy Blackgoat, but she couldn't imagine that jobless troublemaker affording such a vehicle.

At the airport, she parked in front, and the gate-guard let her in.

The spaceplane's shadow stretched across the tarmac, crisp as a new hundred-dollar bill. Perhaps because of the Sun behind it, it looked even more formidable than yesterday. A half-dozen men were already hard at work painting the fuselage white.



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She ran up to the ship, ducking under a wing. An aluminum ladder led up to the open bomb-bay, topped by a pair of khaki-clad legs that were obviously Mallory's.

"Good morning, Mr. Mallory!" Pandora said brightly. "Have you picked a new name for the ship yet?"

He half-turned, glancing downward, and she saw that he was holding a welding torch. The flame vanished, and he flipped up his polarized glasses. "What?"

Pandora turned red. "I was just wondering if you have a new name for the ship. Black Ghost is a lousy bad-luck name, you know. Fine for the Air Force, but not for the first Moon colony ship."

"True, but it's not up to me to name her. That's Stockton's call—one of the privileges of financing this operation."

"He should call it *Eagle's Dream*."

"Well, you tell him that when he gets here. Meantime, when's breakfast? A man could starve to death up here."

"Pretty soon." She dashed into the kitchen trailer, dumped all the remaining bacon on the griddle and started two pots of coffee. There was plenty of flour, so she decided to make pancakes.

She'd just spatulaed off the bacon and poured the first flapjacks when a commotion sounded outside. She threw open the door and saw a dusty Jetstream trailer driving up, a yellow storage truck in tow.

The trailer braked to a stop and a man leaped out, followed by a woman in a neon-blue T-shirt and a tow-headed boy about Mel's age. The man was short and balding, with a dark complexion and merry brown eyes. In a baggy dark suit and suspenders, the sleeves of his white shirt rolled up halfway to the elbow, all he needed was a green eyeshade to look like Horace Greeley.

*Go up, young woman. . . .*

"This is it!" the man exclaimed happily, throwing his arms around the woman and the kid. "Look at her, would you—isn't she fantastic?"

The boy gazed up at the ship, his eyes round as dollars.

"I'd rather it were a little bigger," the woman said. She was pale and plump, with short black hair in a glossy pageboy. Her T-shirt said *Moon Goddess*.

"It's big enough to do the job. Hey, Professor! Get your lazy ass down here! You, too, Jack!"

Mallory jumped out of the spaceplane's belly, followed an instant later by Jack. The two rushed up and shook his hand. "Rick, you old bastard!"

"I thought you'd be here yesterday!"

"The engine overheated in Colorado. How's the 'Sheep-herding Hardin of Canyon de Chelly'?"

Jack looked pained. "Not you too!"

"Just giving you a hard time, man. You're looking great. How's the head, Professor?"

Pandora's eyes widened. Was this Richard Stockton, the backer? He sure didn't match her idea of a millionaire businessman. He was too nice . . . too ordinary to be so rich. Was Bill Gates nice and ordinary? Ha!

"Fine," Mallory replied. "Nothing to worry about." He smiled at the woman. "Ginny, you're prettier than ever. How was the trip?"

"Beautiful, you liar. It's wonderful to get out of the office and see country again. I may just O.D. on fresh air."

"Uncle Dan, what happened to your head?" asked the boy.

"It got too big for his helmet," Jack deadpanned. "We had to cram it on."

Stockton was frowning. "You'll be OK to lift off? Seriously, guys."

"Absolutely."

"Thank you, God!" Stockton clutched his chest like he was having a heart attack. "I had visions of schlepping back to Ariane, and getting bumped by another commsat!"

"The whole world's waiting for those Lucy reruns," the woman said dryly.

Mallory shrugged. "Well, we *did* shoot down a lot of commsats—or knocked 'em down with orbital debris. Why shouldn't their owners be scram-



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bling to replace them?"

"It's a waste of time seeing the other guy's point of view, Professor," Stockton grumbled. "Next you'll be telling me the Chinese have a perfect right to beat us to the Moon."

"They do. Just so long as they do it on the up and up."

"That'll be the day."

"Ginny, great to see you again," Jack said, shaking the woman's hand. "You, too, Jay." He ruffled the kid's hair. "You eaten yet?"

"No," the boy said. "Nothing since burgers last night in Albuquerque."

Pandora remembered the pancakes, and dashed back to flip them before they burned.

They all crowded inside the trailer—Jack, Mallory, Rick, Ginny, and the boy, plus Melvin, several Navajo men, and blonde Leslie, who looked quite unlike a guy on steroids in a men's T-shirt, khaki bush shorts, and hiking boots. Fact is, she looked like a real outdoors babe.

Pandora felt overwhelmed. All these people, and only one griddle and two frying pans! She wished Olivia were here. Poor Dog was probably dying on her.

Ginny came up and introduced herself. "You look like someone elected you chief cook and bottle washer. Can I give you a hand?"

Before two minutes had passed, Ginny had filled the frying pans and the griddle with flapjacks, and Pandora, Mel, and Jay were sitting down with heaping plates.

Pandora felt guilty about eating when she was supposed to be cooking, but from the way the men were jabbering, it seemed that food was not their number one concern.

"How's our schedule look?" Stockton asked as he poured himself a cup of coffee.

"Good," Jack said. "Fact is, we're a half-day ahead."

Dan held out his coffee cup. "We'll be in Mare Anguis singing "Sixteen Tons" before you know what hit you. We'll make the window, don't worry."

"Fantastic." Stockton looked grim. "Let's hope we're the only ones who do."

Jack sat back in his chair, chewing a toothpick meditatively. "If our air and water's gone, we get our guns and go after it. Simple."

"Very simple," Leslie agreed. "Law of the frontier. Which is why I don't think they'll try it."

Pandora's ears pricked up. Where could supplies on the Moon go? Who could possibly take them? The Chinese?

"Rick, are you going to stand there all day holding that coffee pot?" Dan said plaintively. "Because if you are, I'm stealing Leslie's."

"Better not," Leslie warned. "You'll lose a finger."

"Settle down, woman," Stockton said as he filled Dan's cup. "The spacesuit gloves are already made. Don't go changing the specs."

"Right," Dan said, blowing on his coffee. "Mustn't have dissension among the crew."

*Crew? Leslie was one of the crew?*

Dan grinned at Leslie, who laughed and blew a kiss at him.

Pandora's stomach ached, and she told herself sternly that she simply must quit drinking so much coffee. *So Leslie's going to the Moon with three men. She must be quite . . . talented. Quit being such a cat, Pandora! I'm not—what's wrong with saying she's talented?*

". . . haven't signed a contract yet," Leslie was saying, pointing at Stockton with her cigarette—illegal in the U.S., but still sold on the Rez. Henry said she got blacklisted for her political views during the Buckingham hearings last year. What those views were, Henry didn't say.

"They will," Stockton declared. "Just wait 'til the first month their costs come in four times over spec. They'll be tripping over themselves to buy metal from us."



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'They' who? Pandora knew the Japanese were planning to put up a system of solar-powered satellites. Could he mean the Japanese?

Mel looked at Jay. "Are you going to the Moon?"

"Yup." The blond boy attacked his pancakes. "Not right away, though. Dad says I have to finish college first."

"But your Dad's going next Saturday, isn't he?"

Jay smiled and nodded, but the whites of his eyes were pink. He seemed to be fighting back tears.

Pandora didn't mean to be rude, but she could hardly believe it. "You won't see your Dad again until after you graduate from college?"

Another nod. Jay was really chowing down on those pancakes.

"Wow." But of course, you couldn't wrest a living from the Moon without a high-tech education. Calling Stockton gung-ho about this Moon colony idea must be the understatement of the year! How did Jay's mother feel about her husband going off to the Moon with two other men and Leslie?

"I'm going to the Moon after college, too," Mel announced shyly. "My Dad thinks I'm crazy."

"Most grown-ups do." Jay swallowed hard, then blew his nose on his napkin. "But *we're* the future."

Mel nodded vigorously. "Want someone to show you around the Rez?"

Jay brightened. "You'd do that?"

"Sure."

Pandora's stomach still hurt, though she was pleasantly full with breakfast, but she jumped up and helped Ginny. The poor woman obviously needed all the help she could get.

They had just finished dishing out the last of the pancakes when Fred Buck, an Apache married to one of her third cousins, stuck his head in the door. "Boss, we got trouble!"

Jack scowled. "What kind?"

Fred pushed a distracted hand through his rumpled black hair. "Cato found a charm by the back gate. Right out in plain sight, you know? But nobody saw who left it."

"What kind of charm?"

"Evil Way."

"Shit!" Jack tore outside.

Leslie's pancakes were practically levitating in syrup. How did the woman manage to stay so thin? "Let him handle it, Dan."

"Fine by me." Dan sat down. "Pass the syrup, would you?"

Pandora excused herself and went outside.

Jack and Manny Lujan, the crew boss, stood in front of a crowd of about twenty-five people, Manny holding something that looked like a diamond-patterned rag. No—a rattlesnake skin wrapped around a paint can.

Her face heated. She knew what would be in it, but she pushed her way through the crowd and looked anyway.

Sure enough, the can brimmed with dust, signifying that the person or persons whose footprints had lain in this dust would lose his way to evil, suffer bad luck, and die.

"... want a ceremony to get rid of the bad luck, fine," Lujan was saying. Tall and dark-eyed, he wore denim overalls with no shirt and a sun-faded SDI cap. "We'll have one! But we don't quit work to chase down a medicine man. We do that, we blow this month's launch window and break a half-million dollar contract. You bet Mr. Stockton won't do business with us again. And the Japanese? No way they'd trust us as a secondary supplier. Just kiss our jobs goodbye."

"What happens to our jobs if your rocket crashes?" asked a heavy-set man.

Jack sighed. "Hey, it's a *spaceplane*, not a rocket. We eject from the plane, just like any other plane; we buy another with the insurance. Only it won't happen. The ship's safer than a helicopter, and I don't hear you squawking about one of those falling on your head."

The men in the crowd looked side-



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ways at one another. They were afraid for themselves, not just their jobs.

"Bad luck can come to anyone," Rico Naswoodie said. "No matter how good your machine is."

Jack shrugged. "That's life. If it frightens you, Rico, draw your pay and go."

"I'm staying," Pandora said loudly. "I'm not afraid."

Boy, that made their heads swivel! No one wanted to be thought more fearful than a woman.

Fred coughed. "My father-in-law's a medicine man. I could ask if he'd do a ceremony. He might even throw in a Blessing Way for nothing."

Way to go. The only way Dad's friends would do a Blessing Way for these guys was at gunpoint.

Jack's eyes shone. "My man Fred! You call your father-in-law; everybody else, let's get back to work."

The men dispersed, smiling. Lujan threw a tattooed arm around Fred. "*Bueno, cabrón*. That was good thinking."

Pandora thought she deserved some credit, too. Not that she'd get any!

It also occurred to her that since she'd announced she was staying, it wouldn't look good if she left for the rest of the day. Particularly since Olivia hadn't shown up. Somebody had to fix lunch and dinner.

So after Pandora finished stuffing her laundry in the dryers and chatting with Alice Yellowhair, she came back and started lunch.

After all, she didn't need any personal validation from Dan Mallory or Jack Yazzie to live up to the terms of her agreement. The colonization of the Moon was bigger than any of them. Future generations depended on their actions.

And suppose a giant asteroid hit the Earth after the colony started? *The entire future of Humankind might depend on what she did here today!*

So should she fix rice and beans, or bean burritos?

She finally threw together a pot of rice and beans with the last half-pound of cheddar. She was just nuking the remainder of Mallory's tortillas from Hubbell's when Olivia came riding up, a fat sheep trotting behind her horse.

"*Yah-aat-eeh!* I brought dinner."

"Great! How's Dog?"

"Not so good." Olivia dismounted, her striped jasper bracelets jingling.

"How 'bout we take him to the animal hospital in *Tse Bonito?*"

"Animal hospitals want money."

"Jack'll advance you something on your wages. Especially when he sees that sheep. Anyhow, you don't have to pay the vet when you bring him in—just when you pick him up."

"Oh. I guess it won't hurt to try."

Pandora called the crew to lunch, and promptly hit up Jack for money.

"What do you need it for?" Jack wanted to know.

"Her dog's sick," Pandora said. "And she's fixing mutton stew for supper."

All the Navajo stared at Jack, who sighed and flipped open his wallet. "Here's three twenties. Now scram."

Olivia smiled her thanks, and handed the sheep's lead rope to Henry. "Hang onto her for me, OK?"

"Aw, hell," Mallory said, pulling out his wallet. "That's not enough for a sick animal. Not on a weekend." He extracted two twenties and handed them over.

"Gee, can I have some money for my cat?" Pulaski said. "I think she's pregnant."

"Shut up, Tink."

"What am I supposed to do with this sheep?" Henry asked. "And the horse?"

"Keep 'em in the shade," Olivia said. "I'll be back in about an hour."

"But. . . ."

Pandora and Olivia were already running for the parking lot. They jumped in the truck and tore over to Olivia's hogan.

"Dan likes you," Olivia said.

"You're crazy."

"I can see you two together. Like hum-



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mingbirds in flight!"

"Very funny!"

Dog was still alive when they got there, but he looked worse than yesterday. His tail twitched when he saw Olivia, but he was too weak to raise his head. His nose was hot, his eyes glassy.

They lifted his limp body into the back of the truck, and Pandora drove as slowly as possible over the dirt road, but the potholes jounced him despite her best efforts. She didn't get home with the laundry until almost four o'clock.

Mom had that look on her face. "Pandora, what on earth makes you think this is enough time to finish tortillas? You should've been back hours ago!"

"Sorry, Mom."

"You're going to have to learn to cook someday, young lady! Believe it or not, the way to a man's heart *is* through his stomach. What's this gunk on the bottom of the laundry basket? It looks like dried blood!"

"Uh. . . ."

The rest of the day was given over to domestic chores, of which the less is said, the better.

After dinner that night, Pandora hauled out the garbage.

Half full, the Moon shone like a cut pearl, the shadowy seas all the bluer in contrast. She could see why the old astronomers mistook them for water. Here, moonlight turned the night sky navy-blue, and came within a feather's-breadth of making the housing project look beautiful—beehive boxes, propane tanks and all.

A pack of coyotes started yapping before she was halfway down the driveway. They sounded close, like maybe right down the wash, but they had to compete with the screaming of those bratty Cisneros kids, playing some dumb war game right out in the middle of the street. And the popping of distant gunshots . . . well, it was Sunday night. Pandora tuned them out.

Grandmother's right about our people being wanderers. That most of us were now living in one place represents the biggest change we've ever made. But maybe settling down isn't right for us. Maybe it pushed us permanently out of balance. That could be why we have so many problems with drunkenness and violence.

If we follow our wandering blood out among the stars. . . . We'd find our own country again, on the Moon, Mars, and beyond, wherever we have the strength and the courage to roam.

Pandora threw the garbage in the dumpster at the end of the block, scaring three cats out of one life apiece, then stood staring up at the Moon.

If she wanted something bad enough, could she make it happen? Or would she spend her whole life chasing blue water and finding only dry dust?

Pandora supposed that most people were excited about starting their senior year in high school, but by noon she just wanted it over with.

She liked Ms. McCutcheon, her homeroom teacher, and she'd looked forward to seeing her old friends. But Alvin Blacksheep and Xochitl Aguilar, two boys she'd talked computers and science with last year, had suddenly developed a case of the tongue-ties. And Marlinda Kootsvema acted very cool, as if she'd just remembered she was Hopi and didn't pal around with Navajos.

Pandora couldn't be angry with her—she'd chunked on another twenty pounds, plus her face had broken out. The contrast with Pandora's new looks must have hurt. Maybe it was just PMS, but her basketball buddy Kathy Todacheenie didn't seem too thrilled to see her, either.

With Olivia getting her G.E.D. at home, it looked like she'd spend the year hanging out with Melvin. In the meantime, she had to work on her contestant speech.

Olivia was doing the missing-dad-responsibility thing. It was a good subject for her. She'd lucked out with Grand-



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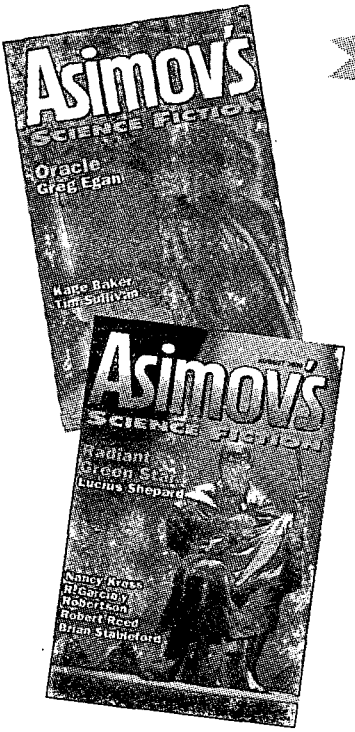


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mother, but lots of other kids weren't so lucky.

Pandora had picked education. Problem was, she didn't really know how to fix the schools, other than getting more books and kicking out the troublemakers. She could think of a few teachers who should have been zeroed during the Clinton administration, but she couldn't say that. The science classes were too dumbed-down, but Mr. Mathison was afraid to make them harder. If he flunked anyone, the parents would scream bloody murder.

She felt guilty competing against Olivia. She could get an academic scholarship if she applied herself. Olivia probably couldn't. Was it right for Pandora to compete for the only prize her best friend could win?

Pandora sighed. The Net and her favorite used-bookstore in Flagstaff were great, but without any real challenge here at school, how did she know how good she was academically? She might win nothing more than a "greetings" letter from Selective Service.

She wanted to write a speech about the nomadic tradition, and how our destiny lies among the stars. But it sounded hopelessly idealistic. Just because Jack was going didn't mean everyone else could.

She headed right for the airport after school, which meant she was sweating buckets by the time she turned her bicycle into the airport driveway. She had until 5:30 to get home. Lucky thing hogans don't have telephones.

Zim Sullivan, a former Marine sergeant and Selene Development's top security man, stood by the front gate, revolver on his hip—not one of those weird-looking smart guns, but a real one. He recognized Pandora and waved her inside.

Strangely enough, there weren't many people around. The place looked almost deserted. They couldn't have all been scared off by the curse, because the Anglos were missing, too.

What better time to get a peek at the spaceplane's insides?

Pandora strolled casually over to the ladder leading up to the bomb bay. *Nobody there.* Heart thudding against her ribs, she started up the ladder.

"Hey, Pandora! You're not supposed to go in there!" Melvin's voice.

Pandora's first thought was to blow off the little twerp. But Mel was like a horsefly, not easily shaken. He and Jay stood in front of the hangar, a soccer ball at their feet. "Why not, pray tell?"

"Because Dan said for everyone to stay out before he went to the meeting," Mel said. "He said that especially means *you.*"

Scowling, Pandora jumped down from the ladder. "What meeting?" These guys weren't the meeting type.

Mel's forehead corrugated. "Didn't you hear about Zielinski?"

"Who?"

"The pilot of the KC-135Q, the stratotanker refueling plane."

"Oh." That Zielinski. "No, what happened?"

Mel smiled beatifically, relishing his role as the Fount of All Knowledge. "He caught some guy sneaking around the stratotanker hanger in Gallup at two o'clock this morning. The creep took off so fast he dropped his backpack going over the fence. And you'll never guess what was inside!"

Ginny appeared in the doorway to the kitchen trailer. "Pandora, may I ask you a stupid question?"

"Oh, sure."

"Do you have Internet grocery shopping here?"

Pandora didn't laugh. "No. Everybody does their own."

"I was afraid of that. Would you point me to a grocery store?"

"Better I show you, rather than let you wander off by yourself."

"I'm sure you've got more interesting things to do."

"Nah." Nothing except stowing away



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on a Moon ship.

Off they went to Window Rock, Jay in tow. And wherever Jay went, Mel went. Pandora managed to keep silent until Ginny pulled out of the parking lot. "So what happened to Zielinski?"

Ginny gave her a sideways look. "He's fine, thank goodness. Do we go left here?"

"Right. I mean, yes, we turn left. What was in the trespasser's backpack?"

"A bomb!" Mel piped up from the back seat.

"Oh, God!" Pandora's stomach did a back-flip. "Did they catch him?"

Ginny's plump mouth formed a grim line. "Unfortunately, no."

"Nick wounded him," Jay added. "They found blood on the ground later. But Nick's got a bad leg since being shot down over Shanghai, so he couldn't follow him over the fence."

"By the time security showed up," Mel finished, "the creep had already jumped in a truck and. . . ." He mimed a zooming vehicle with his hands. ". . . cut out like a bat outta hell!"

Pandora wondered when he'd come here. "Did Nick get the license plate?"

Jay nodded. "It was stolen off a junked car."

"Oh."

Ginny sighed. "Nick said he looked Chinese."

Pandora's eyebrows went up. "You think the People's Republic is trying to sabotage this project because they want to get to the Moon first and steal all your supplies?"

"That's one theory." Ginny shook her head. "But they'd have to be crazy to do it, and I can't see them sneaking into Arizona. More likely it's domestic terrorists."

"Like Earth State," Mel said helpfully.

The ultimate antitechnology crackpots, Earth State had a history of bombing anything more high-tech than an electric can opener. Everyone on the Net was familiar with their 250K all-caps spam-rants. Six months ago they'd dropped off the Net, which may or may not have had something to do with the mysterious bombing of a launch facility in Houston.

"I thought they'd been arrested for the Houston thing," Pandora said slowly.

"Uh-huh. They paid the $250,000 bail and disappeared."

"That isn't much, considering they only have to put up one-tenth. I wish we could link this thing in Gallup to whoever left the Evil Way charm."

Mel snorted. "Lots of Navajo want to live in the past, but they don't go around bombing people. It's hardly traditional behavior."

Pandora smiled sweetly. "I realize that. That's why I said we can't link the two." She explained about seeing Jimmy Blackgoat on the way into the airport.

Ginny seemed even more doubtful than Mel. "None of that adds up. The police don't know of any Chinese in Earth State. And we still don't know who. . . ." Her voice drifted off.

"Who what?"

"Nothing. If I were an American Chinese, I'd be getting my postwar life back to normal, not terrorizing a little company like SDI."

"Maybe they're really mad about being thrown in an internment camp," Mel said darkly.

"But that's not the fault of anybody at Selene Development," Pandora said.

Jay leaned over the front seat. "I bet anything it's the PRC. They've got a personal grudge against pilots like Jack and Dan."

"There's Basha's," Mel said, pointing with his chin. "South side of the street."

Pandora could not imagine how Ginny managed to deal so calmly with the notion that terrorists were out to destroy her husband's company, or the alternative: if Selene Development succeeded, he would be on the Moon indefinitely with Leslie. But Ginny was humming a little tune as she sliced beef chuck into cubes. You'd swear there



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was nothing on her mind beyond making enough *chili con carne* for forty or fifty people.

And what had she been about to say, back in the car?

"Pandora, how did these boys manage to rope you into doing all the cooking?"

"Actually, I asked them for a job. And I'm not doing it all."

"Do you like to cook?"

Pandora blotted onion tears from her eye with the sleeve of her T-shirt. "Not really. I was hoping . . . I don't know. I thought it'd be cool to install software, maybe write a program. . . . But it'd be silly to do all that out here, wouldn't it? You can't exactly run down to the local Radio Shack for replacement parts."

"Right. That was all done months ago in New York. Henry rounded up an army of geeks—it took them a month to program the guidance computer, and a few more weeks for debugging."

"Yeah." Pandora poured a bowl of chopped onion into the sizzling-hot cast-iron skillet. "What were you about to say in the car?"

The older woman sighed. "I didn't want to talk in front of Jay. But. . . ."

"It's about Mallory, isn't it?"

Ginny glanced at her sharply. "My, you're quick."

"Well, whatever happened to him's a big secret, so who else could it be?" Pandora plopped a fat green and black *jalapeño* pepper on the cutting board and sliced it in half. "Did he catch a terrorist—is that how he got that clout on the head?"

"We're not sure. He and Tink were unloading one of the vans when apparently Dan surprised someone inside. Whoever he was knocked Dan out cold and ran."

"Did Tink catch him?"

"No, he was thirty yards away when it happened. He dropped whatever he was carrying and ran to help Dan. Unfortunately, he wasn't looking where he was going, and ran straight into a ladder hanging off the end of a truck. By the time he got back on his feet, the perpetrator was gone."

"But surely Dan must've given a good description?"

"He doesn't remember anything. I hear that's not uncommon with a concussion."

Pandora stared at her, big-eyed. "That's awful!"

"Well, it could've been worse." Ginny dumped beef cubes onto the hot griddle. They sizzled like rain on a campfire, exuding a heavenly aroma. "They've stepped up security, and the launch is only four and a half days away."

Four and a half days. After that, would she ever see Dan Mallory again? Would he even remember her past next week?

"Those peppers are pretty ferocious," Ginny observed. "Want help chopping?"

"Oh, no," Pandora said hastily, wiping her eyes with a tissue. "I'm almost done. You go ahead and start on the cornbread if you want."

"OK."

Blinking hard, Pandora gazed out the window. Really, it was ridiculous for her to be so wound up about Dan Mallory. She barely knew the man, and he wasn't her type at all. She would follow her own personal star, regardless of whether a man happened to see it or not.

"Are kids on the Reservation space-crazy, too?"

Pandora picked up the cutting board, and began scraping diced peppers in with the onions. "Some of us."

"When I was fifteen, I found this wonderful book at a used-bookstore." Ginny's eyes were distant as she stirred buttermilk into cornbread batter. "*The Menace From Earth*. Have you read it?"

"Only about four times."

"It's all Heinlein's fault. Those wings ruined us for Earth."

"But won't you miss. . . ." Pandora stopped, her face scarlet.

"My husband?" Ginny smiled. "Oh, no, not at all!"

"Sorry, I . . . you're kidding, aren't you?"



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"Yes. Everyone, including my hairdresser, asks me that. Of course I'll miss him! I'll be joining him in Luna City as soon as Jay turns eighteen. After two and a half years, it'll be like getting married all over again. Rick promised me a Moon diamond for my next engagement ring."

"Oh, that's so romantic!" Pandora clapped her hands together. "But this whole adventure's romantic. I told Mallory he should call the ship *Eagle's Dream*."

"For the vehicle they used in the first Moon landing?"

"'The *Eagle* has landed'? No, I was thinking that the eagle must dream of flying higher than the sky. What greater challenge could there be?"

Ginny's green eyes were bright. "You've got the passion, hon. Don't let it go. Don't ever settle for second best."

"I won't."

"It's about time for you to get home, isn't it?"

Pandora glanced at her watch. It read 5:25. "Oh, no! I forgot all about the time. Mom'll kill me if I'm not home at 5:30."

Ginny slid the cornbread in the oven. "Well, we can fix that. C'mon, I'll drop you off."

Mom seemed suspicious when Pandora arrived home at exactly 5:30 without being out of breath. Pandora told her that she'd walked the bike on the last part—she had, all the way from the corner. She atoned for her guilt by spending the rest of the evening working on "the everyday skirt" and her speech. Both words and stitches snarled like fishing line in the reeds.

Tuesday it was cloudy by the time she arrived at the airport. If the Sun had been shining, the spaceplane would've knocked her eyes out.

The lower surfaces were still dark, since it was pointless to paint over the major part of the thermal protection system, even with heavy-duty rocket paint. But the rest was pure white, the color of sacred clay. Giving the wings a racier look were six solid boosters about twelve feet long. Called 'snap-on solids,' these engines would give the spaceplane the additional thrust needed to reach the Moon.

Backs gleaming like oiled oak, Robert Dancing Feather and Cato Kinlicheenie stood on ladders just ahead of the front landing gear, painting something on the fuselage.

It said *Eagle's Dream* in script as blue as the sea, an armspan high.

Pandora grinned like a maniac.

As she dashed over to the ship, she saw maybe two dozen Navajos sitting in a circle in front of the back gate, all holding long black feathers. In the center were Fred and a skinny fiftyish man in a cowboy hat. Thin sing-song chanting drifted across the tarmac.

Fred and his medicine man father-in-law. They'd probably be out there for *days*.

Timidly, Pandora touched the paint on the nearest wing. *Dry*. She scrambled atop the wing and walked to where Cato and Robert were painting. The sound of her footsteps on the metal echoed like the ghosts of Chaco Canyon. She told herself to cut the melodrama.

"It looks wonderful, you guys!"

Cato grinned. "Yeah, I heard it was your idea."

She noticed suddenly that the cockpit canopy was open, standing on its nose hinge in a clean arch above the ship. From inside the cockpit came the tinny sound of a radio playing Garth Brooks' latest jazz tune. Though she stood on tiptoes, she couldn't see anyone inside.

Pandora stepped off the wing into the cockpit, jumped down inside, took a deep breath and looked around. It was more crowded than a boys' bedroom, and smelled like kerosene and old socks. The usual dials, gauges, and radio crowded the instrument panel; the computer board looked about ten times



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more sophisticated than the ones cars had for email.

There were dents and scrapes everywhere, black scorch marks on the hatch, and weld marks around the new acceleration couches. Steel racks in the ceiling by the new airlock looked as if they might be designed to hold spacesuits. They were empty now.

A small black radio lay on the floor next to the welding torch, serenading her from a cushion of oily rags.

Pandora sat down in the front acceleration couch, which gave agreeably under her weight. She lay back and looked up at the sky, past the edge of the canopy. The clouds appeared to be absolutely still at first. Then suddenly she saw them move, blowing westward across the sky with incredible speed.

The fingers of her right hand touched the pilot's controls. Almost, she could believe that the sky held perfectly still, and that she and *Eagle's Dream* were moving, flung up into the vastness like a giant's thunderbolt. Soon the clouds would part, and the Moon would appear before her like a great silvery-blue *concho*, the stars around her as thick as corn pollen in June.

The spaceplane trembled beneath her, and Pandora was out of the couch like a shot. Had she ignited it somehow?

Mallory jumped down inside the cockpit next to her. "Hello, kid."

"Oh, hi." She smiled weakly. "Your bandage is gone."

"Yeah, I'm ready to go ten rounds with a tornado." He smiled, but knife-edged lines of weariness showed around his eyes and mouth. "What're you doing here? You aren't planning on stowing away, are you?"

"Certainly not. I've *read* 'The Cold Equations.'"

"Have you, now?" He seemed amused. "It's still not safe for you to be poking around the ship by yourself."

"But I've never seen one up close! And you're too busy to show me around."

He gave her a hard look. "That's right." But instead of ordering her out, he said, "OK, the vortex version. This is our new crew cabin. We added two more couches, then walled off the bomb compartment and installed an airlock. Henry upgraded the guidance computer, and Tink did the snap-on-solids. *Voilà*, instant Moon ship." Mallory looked around proudly.

"And where the bombs were before, that's where you'll put the cargo?"

"Right. The airlock lets you into the cargo space, and from there you can open the cargo bay to leave the ship."

Pandora took a deep breath. Her chest felt as if it had an iron band clamped around it. "Kind of small for four people to be spending five days in." *Especially when one of those people is Leslie.*

He shrugged. "Staterooms probably weren't much bigger on the *Mayflower*, and that trip took six months."

Five days was no time at all, really. Who could understand Anglos? They'd jumped on this country in a heartbeat. How could they stand to have so much wealth now and do so little with it?

"How big is the Lunar Habitat?"

"The tuna can?" He laughed. "A little over a thousand square feet, but we each have our own room. Once we seal off a few lava tubes, we'll have loads of living space. Some of them are hundreds of miles long."

"A whole new frontier, full of brand-new opportunities. . . ." *And nobody taking anyone else's land away from them.* Pandora smiled up at him. "Someday, all the mining will be done in space, and Earth will be one big park. I think this is the most wonderful thing you Anglos have ever done."

"Anglos?"

She didn't understand why he was frowning. "Did I say something wrong?"

"Anglo means 'British.' My ancestors left Ireland during the Potato Famine, after the British hanged my great-great-grandfather for fishing in his own stream."



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"I'm sorry." Pandora looked down, mortified. She'd had no idea those two tribes hated each other like that. Those British were as bad as the Hopi in the old days.

Mallory chucked her under the chin. "Hey, it's not your fault. Nobody's got the right name. You folks call yourselves 'Navajo' when it's an insult in Tewa. Progress these days consists of putting everyone in the wrong box, instead of getting rid of the boxes."

They had edged past the second set of couches to get a better look at the airlock, and now his T-shirted torso was only inches away. He had a kind of rumpled sexiness that gym-bodied movie actors paid millions for and still didn't have. He smelled of engine oil and sweat, the clean sweat of someone who washed every day. Infinitely more attractive than aftershave.

"Did you know there's a moon named Pandora?"

Pandora's heart beat faster. "Maybe I'll go there someday. Where is it?"

He smiled. "Orbiting Saturn. Tiny thing—you'd need a good telescope to find it."

Her jaw dropped. Not that the smile made him handsome—oh, no! His features were plain as tempered steel, plain as logic trees and spaceplanes and pure unalloyed masculinity. That had its own beauty, profoundly outclassing the juvenile prettiness called "handsome." And the glint in those gray eyes exuded more heat than a Pratt & Whitney RL-10 engine.

Her face burned, and she stammered, "Where'd you learn to speak Navajo so well?"

"Growing up in the Painted Desert and Wupatki. Dad was in The National Park Service. Forgot most of it 'til I met Jack at Edwards." Mallory suddenly seemed to realize he was wasting time, for he bent down and grabbed the welding torch. "I'd better get this mess spiffed up for the FAA inspection. Now scoot."

* * *

When Pandora arrived at the airport on Wednesday, she saw a long line of men carrying crates and boxes to the spaceplane. Dan, Leslie, Jack, Rick, Henry, and Zim stood out in front talking to Fred Buck and a skinny old man in an old-fashioned tall-crowned black hat. The old man was Kawoozie Jim from Greasewood.

Despite being in his nineties, Kawoozie Jim was still reputed to be able to track a shadow across a black rock. Fred often guided hunters in the White Mountains, and was a skilled tracker himself.

". . . expect you fellows back so early," Mallory was saying. "What'd you find?"

"There was a campsite, all right," Fred said. "South of here, behind them two hills. Four guys there for two, three days, cleared out not too long ago—couple hours, maybe."

Jack swore. "I bet they crawled up those hills every night and glassed us."

"Plenty of sign showin' they was up there," Fred affirmed. "They done a job of cleanin' up after themselves. Took me two hours to find this." He held out his finger and thumb, exhibiting a tiny disc of oxidized silver—it might've been an earring, or part of a broken necklace.

On it was the split-circle swirl with the two dots—the yin-yang symbol.

Recognition flared in Rick's eyes. "The PRC! I knew it! If those bastards think they can sabotage this launch, they've got another think coming!"

"That doesn't prove it's the Chinese," Dan pointed out. "Plenty of other people wore that symbol once."

"Before the war," Henry said. "Not after."

Stockton glowered. "What the hell, Dan! Why are you always sticking up for the damn Chinese?"

"I'm not. I just don't believe in jumping to conclusions with insufficient evidence. We have no idea how long that thing's been there."

"No tourist go there," Kawoozie Jim



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growled. "Find this, too." He extended his hand, gnarled as a cholla skeleton. In it was a miniature dark-green bead.

It could be distinguished from a weed seed only in that it had a perfect hole in the middle. It looked like an Apache bead, except Pandora had never seen one that color.

"How'd you find that?" Mel asked, pushing past Dan to stare at the bead. Good old Melvin—he was never far from the middle of things.

Kawoozie smiled, so slowly she thought he'd creak. "Easy. I look for hole."

"That's an Apache bead," Jack said. "Are you trying to say the bad guys are Apaches?"

Fred shook his head. "No, it just looks Apache. I don't know whose it is."

Henry made a face. "OK, so we look for a terrorist wearing made-in-China knockoffs of Apache jewelry. Anyone else having a hard time picturing this?"

Everyone nodded.

"Guys, any idea where they went?" Rick asked.

"Back t' 264." Kawoozie dug out a chaw of tobacco and folded it into his cheek.

Jack lit a brown cigarette, threw the match on the ground and stomped on it. "If they went back to the highway, they went into town. If they're in town, somebody's seen them. All we have to do is ask. Then we find 'em and beat the crap out of 'em."

"They'll be masquerading as tourists." Dan pushed his hat back, ran a hand through his hair, put the hat back on again. "Beat up the wrong tourists, and Bluehouse will chuck us out. Even you, Jack."

Jack exhaled smoke. "I know, I know. You're right. I'm just going a little nuts here."

"Why don't we just call the police?" Henry said. "Let them handle it."

Leslie rolled her eyes. "The police here are running ragged chasing gang-bangers and bootleggers. We'll have to catch these guys ourselves."

"The FBI, then."

"I tried that already," Rick said. "They said they're very busy right now, and they'll try to get someone out here in sixty days."

"Are you kidding? We just finished fighting a war with these people!"

"This is the Rez," Pandora said. "The Fibbies don't care what happens here so long as nobody takes a shot at the BIA."

Leslie glanced at Jack and cocked an eyebrow suggestively.

"Don't go giving our anarchist any ideas," Mallory said with a severe look at Pandora.

"Spoilsport," said Leslie. Smiling, Jack slipped an arm around her waist.

Mallory sighed and clapped Fred on the shoulder. "You guys did a great job."

Fred grinned. "No *problemo*. We'll go out again tomorrow, see what we find."

Kawoozie spat a brown stream of tobacco juice. "Too windy tomorrow."

Everyone looked at the sky. There were plenty of clouds, but the air was as still as death.

"We can talk about this more at dinner," Rick said. "Meantime, let's get back to work. Zim, please drive Kawoozie back to Greasewood."

"Yes, sir."

Everybody dispersed then, including Pandora. Or at least, she started to.

"Hey, Pandora," Mel said. "Can I ask you something?"

She stopped dead. "*You* want to ask *me* something? Are you feverish?"

The eyes behind the thick glasses were pleading. "Do you think Olivia likes me?"

Pandora opened her mouth, stopped, then kick-started her brain. "I don't know, Mel. She's never said. You're a little young for her, though."

"I realize that, but by the time we're in our twenties, a couple of years won't matter. The social dynamics are completely different."

"True." A good thing he was looking so far ahead. A case of social ineptitude



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like his didn't vanish overnight.

"If you need any help fixing dinner, I could maybe. . . ."

"Hello, there!" A lean man in a golden-brown suit and fashionably round glasses stood behind the gate. Taking a wallet from his breast-pocket, he flipped it open to show a set of embossed identification with a holo. "I'm Joshua Bright from the FAA, here to do the airworthiness inspection."

Pandora studied the ID, admiring the engraved spaceplanes in the background. "Hang on a second and I'll get Rick."

Mel sighed. "You don't have to bother Rick just to let Mr. Bright in," he said, opening the gate.

"Thank you, young man. I know how busy you all must be—I'll try not to take up too much of anyone's time."

Mel nodded as if he'd been scheduling inspections all his life. "There's the ship."

"Pretty impressive. Would you mind escorting me over there, or should I get. . . ." He consulted a paper from his briefcase. ". . . Mr. Mallory or Mr. Yazzie?"

"I'll take you," Mel said. "We can grab one of them when you're done."

"Excellent. I'm hoping to get it all done this afternoon. I'd love to see Spider Rock before I head back to Phoenix tomorrow."

The two headed for *Eagle's Dream*, Mel yakking up a storm. Pandora considered telling Dan that the inspector was here. But there wasn't anything he could do at the last instant to get the ship ready. The ship must be ready, or they wouldn't be loading cargo. Anyway, she didn't know where he had gone.

As Pandora neared the kitchen trailer, she heard the medicine man out by the back gate, still singing in his high, cracked voice. There were four other men with him today, holding feathers and passing the cup around.

What would the FAA guy think of that? She didn't want to know.

Pandora found Olivia in the kitchen trailer, up to her elbows in dinner preparations.

Olivia looked up, her dark eyes aglow. "Guess what, Dora! Ginny thinks I have what it takes to be a geologist!"

"Really?"

"Oh, I know it'll be a lot tougher than my rock-hunting. I'll have to study like crazy. But she looked at some of my rocks and said they were gorgeous samples, and she'd help me look into the NAU program if I wanted." Olivia flushed. "Did you know she's a geologist, Dora? She can work anywhere, even on the Moon!"

"I didn't know that." Pandora wondered why she didn't share Olivia's excitement. Could she possibly be jealous of her best friend?

Of course not! But why hadn't Ginny suggested a course of study to Pandora? Did she think she'd already decided? Or. . . .

OK, so maybe she was a little jealous. Not only of Olivia, but Leslie, too. Get over it! Mallory might think you're hot, but he's not giving up the blonde babe. How does Ginny encouraging Olivia take anything away from you?

Pandora smiled mechanically. "That's wonderful, Livvy. I hope everything works out, just the way you want. How's Dog?"

Olivia's face fell. "The bullet punctured a lung. The vet put him on IV antibiotics yesterday."

"Ah."

"I figured I ought to wait a while before calling."

Pandora grabbed the phone. "I'll call. I'm sure he's doing better."

The door to the kitchen trailer opened, admitting Mallory, Stockton, Ginny, Jay, and Mel, who looked glumly at her and drew his finger across his throat.

"*Yah-aat-eeh*," Mallory said. "Pandora, you and Olivia have done a lot of hard work in the short time you've been here."



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Pandora put the phone down. "What's up? Are you kicking us out?"

His face was expressionless. "You could put it that way."

Ginny scowled at him. "Dan, you're the soul of sensitivity!"

"I won't soft-soap a straight question."

Stockton stepped forward. "Let me ask you kids something. Do your parents know you're here?"

Pandora thought of lying about it, but suddenly knew she couldn't. "No."

"Olivia?"

Olivia gulped. "My grandmother knows."

"Well, I doubt she knows about the bomb in Gallup, or our nosy neighbors. Mel's parents certainly don't. None of you kids should be here . . . not without their informed consent." Stockton held out his hands in a gesture of helplessness. "I hate to give up three good workers, but that's the way it's got to be."

Ginny gave them a hug and a kiss. "I'm so sorry, girls. I really am."

Pandora's chest felt as if she'd been stepped on by a Brahma bull. "Ginny, are you and Jay leaving, too?"

Ginny shook her head. "We discussed getting an apartment in town, but decided it's safer if we stay here. Everyone's standing watches at night in shifts until the launch."

"*Armed* watches," Mel said with an envious sigh.

Jay thumped him on the shoulder. "We're still buddies. We're going to the Moon together."

"Right!" Mel agreed heartily.

Stockton's brown eyes were no longer merry. The shadows under them, and the glance he gave his wife, told Pandora volumes.

She looked at Mallory. "I want to stay. It's my decision. I'm not a child."

His gray eyes were thoughtful. "Agreed. But you're legally underage. Let's go to the hangar and I'll write you a check." He opened the door. "C'mon, everyone."

Mel was sniffling; Olivia dusted *masa* flour off her hands and swept out the door wearing that stone-faced look she got when trying not to cry.

Pandora's heart filled with bitterness. A check! She didn't want a check, she wanted her dream back.

A floor-fan droned inside the hangar, swirling the dust from point A to point B and back again. It was cooling off outside, but here it remained suffocatingly hot.

Mallory's desk was in a back corner. He wrote rapidly, but when he tore off the checks he stood holding them, as if he'd forgotten their purpose. "The crew voted unanimously to name the ship *Eagle's Dream*."

Pandora nodded. "I'm coming to the launch."

Mallory's eyes narrowed. "You're as stubborn as Leslie."

"Something wrong with that?"

"Just watch us on TV."

Pandora stuck the check in her pocket without looking at it and walked away. Olivia fell into step beside her, putting her arm around Pandora's waist.

"Don't feel bad, Dora. At least we were part of it for a while. That's more than most people can say."

Pandora was looking up at *Eagle's Dream*. How could anyone want to destroy her? How could anyone see the freedom she embodied and not feel *exalted?* Why couldn't terrorists go terrorize each other?

A tear blurred the corner of her eye; she blinked it away.

"I'm coming to the launch, too," Mel stated. "They can't keep us out of the desert."

"Right," Olivia said. "Anyway, I don't *have* a TV."

As they approached the gate, they saw two expensive-looking cars pull up in front. One bore the logo of the local TV news station. Out of the second one stepped two well-dressed men. Cam and his dad!

Councilman Roanhorse wore a butter-



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colored trenchcoat and carried a briefcase under his arm. He was a good-looking man—a dignified white-haired version of his son.

Jack stood before the gate with his arms folded. Pandora couldn't see his face, but she just bet he was scowling. Three people jumped out of the news car, two carrying TV cameras.

"I'm gonna get my horse," Olivia muttered.

Mel cast a longing look at all the excitement. "I'll come with you."

Pandora was afraid Cam had seen her, but the two stopped on the other side of the gate from Jack. She heard rapid footsteps, and turned to see Mallory, Stockton, and Ginny approaching, with Henry, Tink, and Leslie bringing up the rear. The six of them bracketed Jack, Pandora slipping in behind them.

". . . temporary injunction against launching that rocket over there." Councilman Roanhorse brandished a piece of paper, which fluttered noisily in the wind. "Due to your willful endangerment of human and animal life in the flight path of this airport, you are ordered to appear and show cause against the issuance of a permanent injunction. . . ."

Jack reached over the fence and snatched the paper away. "This *spaceplane* poses no more danger on its flight path than any other existing plane!"

"Then why don't you fly it out of Sky Harbor in Phoenix?" Cam demanded.

"You know damn well why. Congress voted to build these spaceplanes during the war. Now they want the Green vote, so they reclassify the B-7 so she can't fly out of a regular airport. Forget that it was the bombing they objected to! The ship's safe for the environment and handles like a regular plane—that's been proven over and over."

"And the U.S. government does not allow recently declassified hardware to be launched outside United States borders," Mallory added. "Otherwise we'd be in Mexico, and so would these jobs."

Councilman Roanhorse struck a pose. "No one is more concerned than I for the future of my constituents! That is why I have consistently opposed this insane project!"

Rick studied the paper. "The court date's Monday afternoon—two days after the launch. Is that the usual way you do things around here?"

"It is," Cam thundered, "when the court perceives a threat to the lives and safety of its citizens!"

"Funny how the court didn't perceive this when the tribe took our money two months ago."

"Let me see that." Jack snatched the paper back. "Hey! This judge retired before I joined the Air Force!"

Wow, talk about a Pandora's box!

Pandora would have slipped away right then, but the cameras had zoomed in for a close-up, and she couldn't leave without chancing Mom and Dad seeing her on the six o'clock news. Unfortunately, Tink chose that moment to lumber away in disgust.

Cam stood staring at her as if frozen to the spot, his eyes filled with betrayal.

When Pandora took out the trash after dinner that night, she saw a cloaked figure standing by the wash. For one wild second she thought it was a ghost.

"Pandora! It's me—Cam."

"Oh!" Her heart slowed. "Hi."

Cam approached, his face dramatically highlighted by moonlight. It was weird how fluid his features appeared as he came closer—kind of soft and androgynous. "You're seeing that *biligaana*, aren't you? That Mallory." The last word hissed out of him.

Pandora's eyebrows flew up. "Are you out of your mind?"

"I wish I were. What other explanation is there?"

"I'm not giving you one. It's none of your business why I was at the airport!" How dare he assume that a man was her *only* motivation!

"Ah, what spirit you have!" he sighed, putting his arms around her. "There is a



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grain of truth in your words. It makes me crazy to see a beautiful girl like you hanging around with the enemies of our people."

She tried to extricate herself. "He's not. . . ."

"Raping our land, polluting our air. . . ." His mouth came down on hers. If he hadn't used an eye-watering amount of breath freshener and said so many stupid things, she might've . . . no, she wouldn't have liked it then, either.

She twisted her face away. "That's *our* airport, in case you haven't noticed. The noble savage is dead, Cam!"

"What's that supposed to mean?"

"Even Jack knows more about being Navajo than you!"

"That Uncle Tom-Tom! Are you trying to tell me you're seeing him?"

"No, you moron!" She broke free, but he grabbed her again and kissed her throat like a starving vampire. When he wouldn't let go, she bent his little finger backwards, he yelled, and suddenly Dad was dragging her away from him and shouting, "Pandora, you get back in this house *now*. You're grounded, young lady!"

Thursday dawned gray and windy.

Pedaling her bike upwind, Pandora was thoroughly bushed by the time she got to the airport. Mel and Olivia stood outside the gate, peering inside like orphans in a welfare line. The whole crew was clustered around the spaceplane, probably doing the final preflight check prior to the engine test.

*Eagle's Dream* shuddered in the wind like a kite caught in a tree. The keening of air blowing across all those metal surfaces set Pandora's teeth on edge.

"Hey, girlfriend," Olivia said, smiling. A rose-print kerchief fluttered about her head.

"Hey, yourself," Pandora replied, wincing as a gust of sand stung her knees. Today wasn't a good day for shorts, but there was no way she could have ridden all the way over here in long pants. "I can't stay more than a few minutes. I'm grounded."

"So are we," Mel said. "Literally speaking."

A short, fat man in a pearl-gray business suit emerged from the parking lot and headed toward them. As red-faced as he was, he probably *was* an Anglo.

"Who's that?" Pandora said.

"Who cares?" Mel turned his eyes back to the ship.

The fat man walked right up to the gate and tried to open it. When it didn't, he looked around for a bell, and then he looked at them. "Excuse me," he said. "I'm here on important business for the FAA. Can one of you let me in?"

"You made a trip up here for nothing," Mel told him. "Mr. Bright did the certification yesterday."

The fat man cocked his head, gazing at Mel with protuberant blue eyes like a gecko's. "My name's Bright, but I wasn't here yesterday. I'm the only one who does certifications for this area."

A sudden, horrible suspicion roiled Pandora's brain. "Mel, you don't suppose. . . ."

The boy looked frightened. "Sir, if you'll hold on a moment, we'll call Security."

Pandora waved wildly at Zim Sullivan, who was watching Jack run across the wing to the cockpit. "Sarge! Come quick! It's important!"

The wind was blowing so loudly she couldn't tell if he heard. It was a relief to see the blocky figure turn and hurry toward them. "Hello, Miss Pandora. Didn't think I'd be seeing you for a while."

The fat man said, "I'm Joshua Bright from the FAA. Mr. Stockton's expecting me."

Sullivan nodded. "May I see some ID, please?"

Pandora watched the man pull cards from his wallet. In addition to his FAA card, he had one of the new "counterfeit-proof" IDENTs, the ID cards with the unrewritable chips containing everything from retina print to dental records.



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Nobody used them on the Rez, but since right after the war started, you had to show one to travel between states.

Of course, nothing was really counterfeit-proof. A good hacker could get around it.

She stared at the spaceplane. Dan and Jack were already strapped in. She told herself the fat man was the impostor, not the one from yesterday!

The sergeant took his thumbprint on the portable reader, then swiped the card. "You're you." He opened the gate.

Mel looked as if he'd been hit between the eyes with a two by four; Pandora felt as if she were suffocating. "Sarge, stop the test!"

"What? Why?"

"We let a man in yesterday . . . he said he was from the FAA. But he wasn't!"

"I *told* you that," Bright said impatiently.

Zim looked alert. "When?"

"Right after you left to take Kawoozie home."

"I took him to the spaceplane," Mel whispered. "He asked me for a glass of water, and then Dan said we had to leave, and I never did get back there. . . ."

"Jesus!" Sullivan clicked on his walkie-talkie. "Rick, this is Zim. Evacuate the airport. We have a possible bomb."

Well, they cleared everyone out, including the medicine man. Everyone except Leslie and Tinkerbell, who'd served on Army bomb squads.

Pandora wanted to stay and assure herself that everything was OK, that there wasn't a bomb. But she couldn't make herself believe it. She would gladly have thrown herself on it if she only knew where it was. She slunk home after giving a description to Lt. Whitehorse.

Mel was lower than a rattlesnake's belly. He couldn't even look at Jack, or Olivia, or anybody. Pandora longed to tell Mallory how she'd wanted to go find him. But she found herself staring at his strong sunbrowned hands, the wheat-gold hair furring his skin. Those hands might've been scattered into a million pieces. She got on her bike and left. Halfway down the airport access road, she got off her bike and threw up.

Mom yelled at her for coming home late. Pandora endured it stoically. But when she couldn't eat her dinner, and Dad fretted about her being sick, it was beyond endurance.

She went to her room and turned on the radio, but the only stations she could get were from Winslow and Albuquerque. No news about the airport in Window Rock.

If the bomb detonated, wouldn't she hear it?

Mom made her come out and try on her outfit and practice her speech until she was sick of it. How could the Miss Navajo contest possibly be here already? It was *tomorrow*.

Finally Mom released her, and she went to bed and collapsed. She lay with the covers pulled up to her chin, staring sleeplessly up at the ceiling. Moonlight painted a sliver of wall silvery-blue.

Tap, tap, tap.

Pandora looked up at the window, and her heart leaped. Olivia!

Pandora jumped up out of bed and threw the window open. "What happened?"

"The bomb was in the cargo space. It was set to explode right after take-off."

"Oh, God! Did they get it out OK?"

"Yeah." Olivia shook her head wonderingly. "Leslie deactivated it with a couple of candy bar wrappers. Tink helped, but—imagine a woman doing something like that!"

"My hat's off to her," Pandora said numbly. Mallory was alive because of Leslie. She'd saved them all, as well as the Moon colony. Pandora was grateful, and would never think anything catty about her again.

"Jack went ballistic about her doing it. He kept saying she could've been killed. But the only alternative was to wait three or four hours minimum for the FBI



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bomb squad to drive over from Albuquerque, and they didn't know if it'd explode by then."

"Drive? Why couldn't they take a helicopter?"

"They said all the choppers were out."

Pandora snorted. "At least they're consistent."

Presently Olivia got on her horse and rode home. Pandora remained at the window, the night air chilling her through her pajamas, wishing she had a souvenir. Something to remind her of *Eagle's Dream* and her crew.

But she already had one.

She could still look at the Moon.

Friday night found her at Window Rock's Navajo Nation Fair, dressed to the eyeballs in a red velveteen blouse, white skirts, fringed sash, belt knife, coral and turquoise jewelry, rawhide moccasins with silver buttons, and a fringed white doeskin jacket. And enough Avon to paint a war party.

The rednecks were at the rodeo, Mom and Dad with Pandora, whose mission was to walk around smiling, pretending to enjoy herself, and in general looking like the next Miss Navajo.

There must've been four thousand fairgoers—she saw *at least* that many trucks parked alongside 264 as they walked in.

She hugged the jacket close. The not-quite-dusky evening was noon-bright with strings of colored lights and flashing ads for rides, drinks, popcorn, Navajo tacos and mutton sandwiches. The smell of popcorn and roast mutton made her stomach growl. She reminded herself sternly of her lipstick.

Little kids rode Shetland ponies, bigger ones the roller-coaster, the Ferris wheel, and the Kamikaze. War whoops turned to delighted screams whenever the Kamikaze flipped upside-down.

Mom and Dad were unusually quiet. Pandora knew they were disappointed with her, but what she could say? It was a relief to spot Olivia and Nanabah.

"I'd like to walk with them," Pandora said.

Mom nodded. "Have them come over here."

Olivia shrieked when she saw Pandora. "You look fabulous!"

"You look more!" Pandora exclaimed.

Olivia was all *Diné*: flashing dark eyes, silver and black onyx earrings, slim figure perfectly graced by ruffled violet velveteen. "I should be home fixing the corral. The sheep keep knocking the fence down."

"Will you quit worrying about those stupid sheep?"

"The good news is, I can bring Dog home tomorrow."

"Great!"

Mom and Dad exchanged greetings with Nanabah and complimented Olivia on her dress. Nanabah graciously returned the compliments, her language so flowery that Pandora barely caught the gist. By the time they started walking again, it was almost sunset.

At the Japanese Tattoo Parlor, Olivia whispered, "Let's get tattoos. That dragon looks *so* traditional."

"What dragon? That's a Japanese horned toad!"

"Here comes President Bluehouse," Nanabah said.

Dad snorted. "Photo-op time."

President Bluehouse headed right for them. "This looks like two of our candidates! I'm Will Bluehouse. Good to meet you." He shook hands with Nanabah and Pandora's parents, then the two girls. In a sport shirt patterned with blue and white triangles, black jeans and a blue windbreaker, he looked neat but comfortable.

Dad was wrong; there were no cameras. Pandora liked Bluehouse—he was young, smart, and progressive without being anybody's puppet. Good to know he wasn't a shameless old hack, as least as far as Miss Navajo was concerned.

"I'm sure you'll succeed at whatever you do," he said, smiling at them.



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"Thank you," Pandora said. "And thanks for bringing the Moon project here. That's exactly the kind of jobs project we need."

He looked startled. "Great—glad you think so. Will I see you at take-off?"

"I doubt it."

Pandora thought for sure that Dad would say something after Bluehouse left, but he didn't. They'd come upon the outdoor stage, with the table for the judges off to one side. It was 8:30—half an hour 'til competition.

"Where'd Grandmother go?" Pandora asked.

"The Porta-John," Olivia replied.

Pandora had a sudden urge to locate one herself. "I'll go find her."

"Better hurry," Mom said.

But Pandora didn't see Nanabah anywhere around the nearest row. At her age, she might be in there a while. Pandora found an empty one and endeavored to avoid suffocation.

Returning, she cut through VIP parking.

". . . what will happen out there at dawn tomorrow," she heard a rough male voice say in Navajo.

"I told you to stop following me." The second voice, deep and resonant, sounded familiar. Both men were on the other side of a maroon and silver SUV.

". . . blow them all into clouds, flying machine, president, and all. Perhaps you move up then, eh?"

*Flying machine? Did he mean the spaceplane?* Pandora stopped dead. Thankfully her moccasins made no sound on the gravel.

". . . drunk. I don't know what you're talking about." The SUV's door slammed.

"Oh, yes. I think you give me much money, then I don't tell nobody."

"I've paid you plenty already . . . how much do you want?"

Councilman Roanhorse! Pandora listened to him and the other man argue about money. She couldn't picture Roanhorse allied with terrorists . . . on second thought, yes, she could. He was that ambitious.

And who'd be a shoo-in for Tribal President if Bluehouse died in the stands?

Pandora scurried around a blue Toyota. It gave her enough cover to slip behind a Ford, and from there walk nonchalantly out of VIP parking.

Her heart beat faster than hummingbird wings. Who could she tell? Mom and Dad? They'd believed her in the past, but since the episode with Cam . . . no. She couldn't blame them, but this required immediate action. Who was the blackmailer?

Call the airport and tell Jack. He'll take action. Mallory would, too, but she quailed at the thought of talking to him.

"Pandora, you're number seven," Mom said.

"What?"

"You're the seventh contestant. Better get backstage . . . Olivia's there already."

"Right," Pandora said blankly.

"Don't worry, little one," Dad said. "You'll do fine."

"Backstage" was your basic canvas tent, its local atmosphere supersaturated with hairspray and estrogen. Dressed and made up to the eyeteeth, the other eight contestants were sitting around looking bored.

Pandora borrowed Melinda Goodluck's cellular to dial the airport. No dial tone. She tried again—no luck. "Your phone's screwy."

Melinda shrugged. "It's the fair."

The fair power shortage. Practically every year it shut down half of Window Rock.

"Shit." Pandora dragged Olivia and Nanabah into a corner and told them what she'd heard. "Without proof, will President Bluehouse believe me?"

"Tell him anyway," Olivia said. "*Make* him believe you."

"I saw Councilman Roanhorse," Nanabah said. "He with Jimmy Blackgoat."

Olivia's eyes rounded. "That no-good criminal?"



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"*Aoo*. He'll do anything for money, that one."

Pandora remembered now where she'd seen that SUV—coming out of the desert Sunday. Perhaps Roanhorse loaned it to Blackgoat, the logical source for an Evil Way charm. Had Jimmy been the 'Chinese' Zielinski spotted?

"Bluehouse is skeptical by nature," Pandora said. "He won't believe anything this garbled. *I* think there's another bomb."

"Maybe Jimmy was talking about the old one," Olivia said dubiously.

"And maybe he wasn't. Somebody's got to warn the crew. If you loan me your horse, I can be there in five minutes."

"I'll come with you. You take Nanabah's horse."

"That won't be necessary. I'll only be gone ten or fifteen minutes, tops."

"Girlfriend, if you think I'm going to let you drop out of this contest now, you're crazy. I'm coming along, just to make sure you come back."

"I'm not dropping out, Livvy. And I need you to tell them I'll be right back if by some wild chance I'm a few minutes late."

"I don't like it. It's getting dark, and it looks like rain. . . ."

"You ride in the dark sometimes!"

Olivia finally conceded that a shortcut through the desert made it less than a mile to the airport, and that the other girls would take at least fifteen minutes apiece with their speeches and parading around.

Two minutes later, Pandora trotted the buckskin gelding into the scrubby field southeast of the fair.

No cactus grew here, no prairie dogs dug treacherous holes. Creosote bushes, stunted pine, and bunchgrass rippled white-pink-gold in the lights of the fair.

Pandora urged the horse to a gallop. Well-rested and eager for a run, he flew across the field, the clean autumn wind whipping his rider's cheeks.

Pandora was surprised not to see any lights from Basha's or Hogan Tso a half-mile to her left. They were dark, and so was the Notah Begay Golf Course ahead. Then she remembered the power outage.

She heard only the whistling of brush, the squeak of the saddle, and the pounding of hooves on earth. Several coyotes yapped suddenly nearby, scaring her silly. Most Navajos would have bolted for home right then.

The golf course was deserted; the pampered grass perfect for a night gallop. That lasted maybe two hundred yards, then they hit desert and had to slow down. The last thing Pandora wanted was for the gelding to trip and hurt himself, or throw her into a barrel cactus.

A few airport lights gleamed ahead. Pandora skirted the west fence, heading for the south entrance.

She was a hundred and fifty yards away when something dark and shiny reared up from behind a clump of sotol.

The horse reared, whinnying in fright. Terror gripped Pandora's heart, the night terror of demons and skin-walkers, of the coyotes' warning she'd failed to heed, and she clung to the gelding with all her strength.

Windshield-glimmer in the moonlight. A black truck, driving with its lights off.

Pandora kicked the gelding, but it took forever for her heel to touch his flank. She galloped into darkness, the darkness of a black hole.

A voice from the bottom of the Grand Canyon said, "*Yah-aat-eeh*, Pandora. About time you gave me the pleasure of your company."

Her head throbbed like peyote drums. She seemed to be lying on the Earth somewhere, but she wouldn't bet on it. More likely a planet the size of Jupiter. Gravity fought her eyelids to a standstill, then somebody called for a second round. It might've been her. An eon later, said eyelids opened, showing a familiar face distorted by moonlight. "Cam?"



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"How nice, you remembered! Isn't that nice, Forest?"

The man he addressed gave him a dirty look. "I told you not to use my name." Naked except for a breech-clout, he sat in the lotus position, silvery hair haloing his head. He looked like a grumpy elf. Pandora wanted to laugh, but it would've made her head hurt worse.

"Oh, well, I forgot." Cam giggled.

It gradually penetrated her brain that he was drunk, that her hands were tied behind her back, that she had failed to warn the crew. And there was a decidedly non-elf-sized shotgun on the ground beside Mr. Lotus Position. Probably in the loaded position.

"Well, m'dear, it's a good thing for you that my bootlegger friends recognized you. They might've left you right where you were."

Fine with me. The horse wouldn't have thrown me if they hadn't been driving in the desert without lights.

"*He* isn't going to like this," Forest said. "When *he* returns. . . ."

"*He* doesn't have to know about it." Cam leaned against the open door of a gray truck and chugged a beer, a pair of tall hills silhouetted behind him. No, not a truck—a Halfling. Half high-tech car, half truck, half electric, half gasohol. It wasn't his, that was certain.

A chill percolated through Pandora. She didn't think he was planning to drive her back to the fair. And what was the story with Forest and his nameless friend—why did they fear being identified? Were they bootleggers? No, Cam just said that the bootleggers brought her here.

Forest smiled coldly at him. "I'm not drunk, and neither is *he*. You know our witness policy."

Witness *policy?* Suddenly it all came together: the yin-yang symbol, the green bead, Forest's odd appearance, the Halfling, the level of fanaticism implied by the phony FAA inspector with the bomb. *Earth State.*

Shit! They'd dump her dead body in the desert for the buzzards.

Pandora twisted her shoulders as if trying to get comfortable, pressing the back of her hand against the knife in her sash. *Still there!*

"She's hot for me," Cam drawled. "See how she's wigglin' around?"

Forest sniffed. "I don't advise rutting. They'll be back in less than ten minutes."

Pandora pulled the knife out and turned it upside-down, then began sawing the rope securing her wrists. The numbness invading her fingers made it hard work, and the blade felt as dull as dishwater.

Cam loomed over her. "It might take a little longer than Fearless Leader thinks before the whole airport crew passes out from that spiked beer. . . ."

He squatted down and grabbed her, staggering as he slung her over his shoulder. Pandora jerked on the sawed rope and felt it rip in half, then whammed her elbow as hard as she could into the back of his neck.

"Ow! You bitch!" He dropped her and grabbed his neck—a good thing for him, since she still had the knife. The instant her feet hit the ground, she shoved him into the stunned Forest, who was trying to simultaneously aim the shotgun and untangle himself from the lotus position.

She jumped into the Halfling, slammed the door and locked it, banging her shoulder painfully on a long metallic shape protruding from the passenger seat. She blinked in disbelief. It was a Thorn, a shoulder-mounted weapon that was the successor to the Stinger missile!

Somebody hammered on the window.

Her hand found the keys in the ignition. *That proves it, there is a God!*

Pandora was scared they had another set, but too busy to worry about it. The engine caught with a roar like a prehistoric beast. She jammed it into gear, hit the lights, and floored it.

Tearing across the rocky ground, she



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bounced around inside the cab like a Mexican jumping bean. She didn't know where she was—maybe behind those two small hills south of the airport—but she could see that the dashboard console had e-mail capability.

She booted up, praying that somebody on the crew was doing e-mail tonight. If they had power . . . if they weren't all unconscious from spiked beer . . . wouldn't they all want to celebrate after the hard work they'd done?

A boom rattled her teeth and the rear and front right windows exploded. Cold wind swept through the vehicle, smelling of gunpowder and rain.

"You have mail," the dashboard chirped.

The Halfling bounded down a slope; she yelled, "Send mail! Send mail!"

The shotgun boomed again, harmlessly. She spun the wheel, narrowly avoiding an arroyo; the vehicle bucked and fishtailed. Scattered lights gleamed maybe a half-mile ahead—the airport, she hoped.

"Ready to send mail," the dashboard reported primly.

She shouted into the microphone: "*To* selenedevelopment.com. Have stolen Earth State vehicle and am headed for airfield with two of them in hot pursuit. Armed and dangerous! Will be there any second! Pandora. *Send now.*"

The e-mail warbled into the ether.

The Halfling leveled out; she floored it again, just as lightning veined the sky. She saw running figures in the rear-view mirror, surrounded by dozens of . . . sheep?

A black ravine loomed ahead. Pandora hit the brakes desperately, felt the wheels skid, and then launched into space—

Pandora got to see the take-off, despite being knocked unconscious twice in one night. The ER doctor congratulated her for having an extremely hard head. Dad said that was true in more ways than one—he and Mom were so relieved she was still alive, they hardly yelled at her at all.

When Pandora didn't return, Olivia and Nanabah found President Bluehouse and told him everything. He sent two men to investigate, who found the crew and the airport staff already up in arms. Apparently Tink had started celebrating early—whatever the bootleggers put in the beer made him crazy enough to fire Jack's suspicions. Bluehouse's men ran to the police station, and being Bluehouse's men, actually got one to come with them.

To make a long story short, Pandora's e-mail arrived right after the airport staff took the cop up in one of their helicopters. Mallory radioed the message to them, and with the able assistance of Jack, Zim, Henry, and Fred, they captured three terrorists, four bootleggers, and Cam Roanhorse. (They also found the gelding with Olivia's sheep.)

Dawn brought four thousand people to the airport, along with CNN and a zillion TV cameras. President Bluehouse made a speech praising Pandora and Olivia for helping the police capture this notorious band of terrorists. Pandora blushed, and Olivia insisted that Mel stand up with them, not only for getting the e-mail, but for identifying the phony FAA inspector among the suspects.

"Why were you online here last night?" Pandora whispered.

Mel looked innocent. "Waiting for Jack and Leslie's wedding to start."

"*Wedding? Jack and Leslie?* Are you serious?"

He nodded. "They planned to have Rick marry them on the Moon, but the bomb scare made them move it up. You and Olivia would've been invited if you hadn't been in the contest."

"But I thought Leslie was dating Dan!"

"You did? Why?"

Pandora couldn't think of why, but the crowd kept applauding and yelling "speech, speech," so she stepped forward to make her Miss Navajo speech.



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That is, she started to, but before she even got to the part about how she was going to space, Mallory and Jack came up and kissed her, right in front of everyone!

Mallory growled, "You crazy little fool, why'd you risk yourself like that? I thought you were dead when they pulled you out of that ravine!"

Pandora caught her breath. *He kissed me!* "Why do *you* risk yourself for something you believe in?"

The reporters took tons of pictures: the crew in front of *Eagle's Dream*, Olivia in her Miss Navajo crown with smiling Jack in his p-suit, and of course Jack, Leslie, Dan and Rick waving as they boarded the spaceplane.

Lujan shouted, "There she goes!"

Flame leaped from the belly jet, red as fire opal, then blue-white. The engine roared, shaking Pandora's bones like a hawk snatching a dove at the end of a mile-high dive.

*Eagle's Dream* lifted off the runway, so slowly Pandora feared it would crash to the ground at any second. She felt as if she were underwater, unable to breathe.

About fifty feet up, the rear engine lit, then the snap-on solids. The spaceplane shot into the sky at an acute angle. One second it was hovering, the next, *whoosh*—a shrinking dot on the other side of Apache County.

Everyone was jumping up and down and shouting. Mel and Jay shrieked themselves hoarse; Ginny and Olivia hugged Pandora, who blotted her eyes on her sleeve and looked at Mom and Dad.

The dawn glowed in their faces as they sat gazing up at the sky. "Man," Dad said, awestruck. "*Nizhoni!*"

Mom rested her head on his shoulder. "You know something, honey? Jack and his friend—they remind me of the Heavenly Twins."

Navajo has no word for friendship between a man and woman. Well, maybe it's a little more than friendship between Pandora and Mallory. They've been exchanging a lot of e-mail. □

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# METEORITES: Those Odd Little Rocks

George W. Harper

Some ideas—and other things—go away and come back in new forms.

One of the greatest hazards to any seeker after knowledge is the threat of the unconscious premise or concealed assumption, where data is interpreted without allowing for legitimate alternatives simply because the interpreter accepts his presuppositions without rethinking them.

It boils down to the old adage, "What you don't know is not half so apt to hurt you as what you do know that ain't so!"

I suspect this may be applicable when it comes to our understanding of meteorites. But to explain my reason for saying this I need to provide a little background information, so bear with me for a while.

First for a bit of nomenclature in order to avoid confusion. There are *meteors*, but there are also *meteorites*. A subclass of the meteor is the *bolide*, which may remain a meteor, or under other circumstances, transform into meteorites. Lastly there are the *asteroids*, which may be classed as very minor, pretty minor, or "run for the hills 'cause we're in trouble!"

A *meteor* is the streak of light which races across the sky and than vanishes. In general, it is produced by a fragile, pea-sized bit of ejecta from a comet, called a *meteoroid*. It enters the upper atmosphere at a hypersonic speed in excess of 11.2 km/sec, and promptly incandesces from the friction of the atmosphere. Once burned up, it later falls to Earth as minute specks of dust or vapor.

Occasionally, a larger chunk of matter enters the atmosphere. It might be the size of a baseball, or even a basketball. Often it consists largely of ordinary "dirty" ice, i.e. with frozen methane, ammonia and small particles of dust and debris mixed in. Frictional heating and the stresses of entry into the deeper atmosphere erode the object to point where it lacks the internal cohesion to remain reasonably intact, at which time it explodes in midair, usually with a dramatic



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puff of smoke and rarely, with an explosive bang. This type of object we call a *bolide*.

The third type is quite interesting. For the most part, it is an ordinary chunk of stone, but nickel-iron is not unknown. Its size at entry to the outer atmosphere probably averages around 20 to 25 cm across, but meter-sized objects are not uncommon. It is rather unlikely that these objects are cometary in origin. They lack the fragility associated with cometary debris, so when they enter the outer atmosphere and begin their incandescent plunge to Earth, they are quickly slowed to subsonic speeds without being destroyed. Most are pitted and abraded by frictional forces, but they reach the ground largely intact and with a slow enough speed that they do not leave a massive crater. Often they just sort of plop to Earth and wind up resting comfortably in some farmer's field, where they remain, patiently waiting for someone to stumble across them.

Where meteors either burn up or explode as bolides after entering the atmosphere, those pieces that make it to the surface as recognizable objects are *meteorites*.

Asteroids are distinguishable from meteoroids by their mass. But it is not simply a case of saying a 1-meter object is a meteoroid, while a 1,000-meter object is an asteroid. The basic criterion is the condition of its arrival at the surface. If an object is small enough to be slowed to subsonic speeds, it becomes a meteorite. But an object so massive that the atmosphere cannot significantly reduce its speed below 11.2 km/sec is going to penetrate deeply into the ground and make a noteworthy crater.

The kinetic energy of an impact can be expressed as $mv^2/2$, so it is evident that any estimate of the size of an entering asteroid is a function of its terminal speed. The same crater can thus be argued as deriving from a 50-tonne object, or equally by a 1000-tonne object, depending on the terminal speed postulated.

There is considerable blurring around the edges in these definitions. Hollywood does it routinely with such wild misnomers as *"Meteor!"*, etc., and even professional astronomers have been known to treat them rather cavalierly. But in general they are pretty accurate.

Asteroidal impacts are rare, but meteors and meteorites are constantly entering Earth's atmosphere. It is estimated that on an average day, our planet gains a bit more than 50 tonnes in mass from these objects. This is the lowest estimate and the actual figure may be 500 tonnes, or even more. Day after day, week after week, year after year, the growth continues. We don't notice it because the Earth is so immense that even the highest estimate is only enough to cause each of us to tip the scales about a gram heavier every few million years, which is insignificant . . . unless you happen to be in the path of one of the larger ones, which would be messy.

We are pretty well convinced that meteorites have a rather different origin than cometary meteors. Some are believed to be ejecta from the moon or Mars, but most are assumed to be fragments of shattered asteroids, though none have been formally announced as such and no hint of proof exists. There is also a nagging hunch that at least a few of these meteorites may have come from outside the solar system, but no proof of that exists either.

Our acceptance of meteorites as dropins from space was not always routine. No less a luminary than Thomas Jefferson sneered at those who argued for the possibility of meteorites coming from off-world and declared he could believe almost anything rather than the idea of stones falling from the sky! In general, this mirrored the attitude of astronomers and 'natural' philosophers, as physicists were called in those days. The heavens were a perfect place and it was unthinkable that pebbles might be arriving haphazardly out of heaven.



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A minor asteroid capable of demolishing a town or two was acceptable. Such an event would clearly be an act of God as punishment for the sins of the local populace, but mere rocks would suggest that God's creation was less than perfect, so the meteorite was dismissed as a superstition of the laity. Literate individuals and scientists knew better!

In view of this attitude, acceptance of the extraterrestrial origins of meteorites was tardy in developing and occasioned much opposition from the intelligentsia. But our increasing understanding of the Universe progressively eroded theological dogma and by 1900 or thereabouts, astronomers and the more literate people around the world had come to accept them. Today they are eyed with eager fascination by millions of people who gaze upon meteorites through the glass cases of museums around the world.

As a guess (no one can hope to get an exact tally) the total number of recovered, identified meteorites is somewhere in the vicinity of 50,000, with roughly half being in the possession of rockhounds and farm folk around the world. A few have even become objects of worship. I don't know whether the tiny piece of iron atop King Tut's chest was a meteorite, but Tut met his end several centuries before the start of the iron age, so I suspect it was a meteorite, absent any knowledge of a detailed metallurgical analysis.

Either way, meteors and meteorites have evoked awe and dread for hundreds of generations. But it has only been in the last half century that astronomers have really started focusing attention on meteorites as potential mines of information regarding outer space.

Prior to this, there was considerable very good research, despite the limited tools available. Basic chemical analyses were performed and general classifications of meteoritic types were set down. But an unexpected side effect of this was to render virtually every one of these early meteorites unusable for modern science. They were so contaminated by terrestrial material that sophisticated analytical probing became impossible and only in the past two or three decades have we started getting important findings from newly-discovered meteorites.

The older meteorites are now largely museum items, to be oohed and aahed at by the laity, but otherwise scarcely more than space junk cluttering up the place.

This is where things start getting murky. Only a few of the most recent meteorites offer much in the way of new data, for the same reason that the older findings are of limited value.

A meteorite landing squarely in the middle of a southeast Asian hog wallow may be interesting, but it is certain to be so contaminated by its landing environment that few findings can be regarded as unambiguous. Astronomer "A" may argue that he was able to extract uncontaminated core material proving "this" or "that", but astronomers "B", "C" and "D", feel free to shout, "Nonsense! There are a dozen ways it could have been contaminated without your knowing it!"

The same difficulty applies to the meteorite landing in an Iowa corn field, the roof of a tenement in New York, or even in the middle of the Gobi Desert. About all we can do is subject it to a chemical analysis and assign it to one or another of the traditional categories. The surrounding air and ground are simply too loaded with bacteria and other contaminants to provide much in the way of new data.

But this does not mean there is no hope. There are a few places in the world which are essentially uncontaminated. And as it happens, these are precisely the places where they are apt to be discovered by persons with sufficient scientific know-how to insure that recovered meteorites remain uncontami-



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nated.

Antarctica is the most productive of these locations. Save for the coastal regions, it is virtually abiotic, so contamination is difficult. The temperature is low enough that snow does not readily melt and seep into the more fragile meteorites, though some of them may have been warmed enough by air friction on their descent to acquire a bit of surface moisture from a quick melt and even quicker refreeze. Best of all, snow is white and meteors are black. An entire winter's output of meteorites stands out in stark contrast to their surroundings. A leisurely summer afternoon's helicopter ride with binocular-armed observers surveying the terrain may reveal a half dozen meteorites; all of them virtually pristine in their purity.

Which ain't half bad, considering that the vast majority of us humans will go an entire lifetime without ever finding a single meteorite!

It was one of these Antarctic finds which created such a stir back in 1998 when it was declared to be a bit of ejecta from Mars which showed clear inclusions of exceedingly primitive fossilized microbial life.

This announcement was promptly challenged by physicists who believed Mars had to be sterile now and had to have been sterile from the beginning. Alternative interpretations were advanced and the net result of the initial declaration and subsequent challenges is a firm "maybe!" It could be an indication of life on Mars; or again it might not be.

Which is probably just as well. We won't really know until we get there ourselves. Until then about the most we can hope for are hints and suggestions.

For the moment, I propose to leave it at that and examine some of the peripheral problems. For one, why are we so sure this meteorite came from Mars? For another, how did it get here? For a third, how old is it?

These are all valid questions, and for the most part, they have valid answers.

Fly above a forest of pines in the summer and we are struck by the dark green of the needles. Fly over a corn field and the green is lighter and of a different texture. A Drug Enforcement Agency airplane can fly several thousand feet over a forested area and inerrantly pick out marijuana plants interspersed between the various evergreens and deciduous trees.

The same applies to rocks and minerals, and even to vast regions of the seas. There are visible differences which catch even the untrained eye.

An outgrowth of this has been the development of three- and nine-color photometry. The results are not as precise as spectroscopy, but they are still highly accurate. As an added bonus, they do not require elaborate equipment. Some off-the-shelf light-metering equipment and an assortment of ordinary high-grade filters do quite well, thank you.

When you are done, you will be able to say, "This object has an intensity of 100 in white light. With a mid-range red filter its intensity is only 17, while its mid-range blue intensity is 58, which leaves a mid-spectrum intensity of 25."

Now all you have to do is shop around looking for local materials having the same color distribution and subject them to chemical analysis. Using this approach, you won't be able to make positive identification of remote objects, but you will be able to exclude all save a few possibilities. Using more precisely calibrated laboratory equipment and a nine-color filter system, you can come up with a 98 or 99 percent probability.

It is this technique which permits the astronomer to say the meteorite in question came from Mars. The color distribution of the "Mars" meteorite is a reasonably precise match of color distributions observed on parts of the Martian surface.

No, it is not absolutely certain the meteorite came from Mars. Absolutes are seldom come by in astronomy. But it



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would be safe to say it is extremely likely the meteorite did come from there. Call it a 95+ percent likelihood and we will probably not be far from the mark.

Though not an ideal answer, this at least solves the first question of how we know it came from Mars.

Now for the question of how it got to Earth. And here the answer is pretty clear-cut.

For a chunk of rock to escape Earth via a natural mechanism, it must be ejected with an initial velocity somewhat in excess of 11.2 km/sec. Lacking this speed, the Earth's gravity will gradually slow it, and in due course it will fall back to Earth. For it to go into circular (or near-circular) orbit about the Earth, we need a speed of 7.92 km/sec. Positions of the Moon and Sun, together with the retarding effect of air molecules, may modify these values slightly, but the figures I have given are close enough for use here.

What natural forces could impart such an impetus to an innocent little rock which is merely doing its thing, lying quietly on the ground? A volcanic eruption, perhaps? Not likely, but remotely feasible when we start looking at some of the hypervolcanic eruptions of past ages, eruptions such as those which created Yellowstone Park, for example.

If we stretch our imaginations, we might visualize the initial impetus of the explosion as ejecting material at speeds hovering around 2,000 km/hr, or 0.55 km/sec. While far below the 11.2 km/sec required for escape, one may still argue that occasional bits and pieces of the ejecta *could* have acquired the needed velocity via kinetic impacts from larger fragments being spewed from the same eruption.

It is wildly unlikely this ever happened, but if we make all the right postulations and add the cumulative totals together, I suppose we should concede it might occur once in a while. But the order of probability that it *did* happen is in the neighborhood of 0.00001 or less.

When we consider the much smaller gravity of Mars and its 5.0 km/sec escape velocity, the likelihood of this happening increases, but it remains minuscule and I doubt if anyone knowledgeable in basic physics would ever argue that it actually occurred.

A minor asteroid impact is the only local natural force we know of which is capable of causing the ejection of mass from a planetary body. And we know there have been plenty of those over the aeons. A few millions impacting the several planets of our solar system would probably be a conservative estimate. A few dozen millions might be a better estimate when we pause to consider that the planets themselves probably grew by means of serial impacts onto a core seedling asteroid.

Ignoring the rest of the Universe and limiting ourselves simply to Earth for a few paragraphs, if it requires an initial thrust of 11.2 km/sec to escape altogether from Earth, the corollary observation is that an object at slightly less than infinite distance starting with a zero speed will impact Earth with a terminal velocity of 11.2 km/sec. This 11.2 km/sec is therefore the base speed from which we must begin our calculations and no matter what we do we will either be adding or subtracting from this figure.

Start with a special case subtraction. Postulate a minor asteroid which was somehow injected into a minimum-altitude circular orbit about Earth. Call it a *Mir* space station and I am speaking of an actual case.

Here we have an object starting at very much less than infinite distance. A minimum-energy circular orbit skimming just above the surface of an airless planet will be moving at a speed equal to the required escape velocity divided by the square root of 2. This means the *Mir* could be expected to impact with a terminal velocity of 7.92 km/sec, were it not for the retarding effects of our atmosphere.



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Since the *Mir* was essentially hollow and not at all aerodynamic, it broke up on entry and largely burned up in our atmosphere. A few bits of junk made it back to the surface more or less in one piece, but that isn't the point.

I used it as an example to illustrate the maximum subtraction allowable from the basic 11.2 km/sec direct entry value. If Earth had a 2 or 3 km natural satellite in a slowly decaying orbit, it would be significant, but we don't, so I will ignore this minimum and consider only more reasonable scenarios.

One which is directly pertinent is the Earth's rotation. This is a plus/minus variable, but an asteroid approaching the equator for an elongated, grazing impact will either gain or lose an effective 0.46 km/sec on impact. The limit is now between 11.66 km/sec and 10.74 km/sec. Either would be thoroughly nasty, but the minimum would not be quite as bad.

Things start to get complicated when we crank in the proper motions of both Earth and the oncoming asteroid. Our Earth is tracking around the Sun at an average pace of about 30 km/sec. Now suppose the impacting asteroid is in retrograde orbit so we have a head-on collision!

The orbital impact velocities thereupon total 60 km/sec, but we must also crank in the 11.2 km/sec added by Earth's gravity, giving us a terminal impact velocity of 71.2 km/sec! We can ignore the 0.46 added or subtracted by a limb impact as trivial. This is quite enough to do considerable damage.

But it is not the worst case scenario. If the asteroid was plunging straight toward the Sun but was deflected just right by Earth's gravity, it could theoretically impact with a terminal velocity of 42.4 km/sec. Throw in our velocity of 30 km/sec plus the 11.2 km/sec imparted by our gravitational attraction and we arrive at the horrendous figure of 84.6 km/sec combined speeds at the moment of impact. Crank in the effects of an adverse limb impact and the final result is just over 85 km/sec!

This sets the minimum and maximum values for asteroids impacting Earth; a range which falls between 10.74 and 85 km/sec.

Of course, this is restricted to asteroids which are members of our solar system. If we propose an occasional stray coming in retrograde from outside the system, we could wind up with impact speeds hovering around the 200 km/sec mark. But let's not think about that. A hypothetical observer in orbit around Neptune could probably spot the impact flash on Earth with the naked eye.

Now that I have gotten all the extreme numbers down, it is time to start being realistic. We have no evidence of any extra-solar system impacts over the ages and retrograde impacts are a real rarity. In general we can expect an impacting asteroid to strike from a crossing or overtaking position with an initial velocity no more than perhaps 5 or 10 km/sec greater than our own, which works out to a terminal velocity on impact ranging between 16 and 21 km/sec.

The same asteroid impacting Mars with its more distant orbit and lesser gravity will generally strike with an impact velocity ranging between 10 and 15 km/sec.

Postulate a stony asteroid 1 km in diameter and a mean density of 2.0 $gm/cm^3$ entering our atmosphere with a terminal velocity minimal at 16 km/sec. This is a reasonably conservative all-around set of factors. To this we add the caveat that the asteroid is plunging straight in, which means it will enter our atmosphere roughly 110 km above the surface. If there were no atmosphere the asteroid would travel this distance in roughly 7 seconds!

So what is the effect of the atmosphere on our hypothetical asteroid?

Any knobby projections will be shattered and stripped away by the air resistance. The outer 2 or 3 cm of the sur-



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face will incandesce and evaporate. But the main bulk of the asteroid will survive quite nicely. In fact, it will have a net effective gain in mass as a bow wave of massively compressed atmosphere forms ahead of the asteroid. At the speed it is moving, the air simply hasn't time to get out of the way, so it is accelerated to hypersonic velocity which makes it just as lethal as the main bulk of the plunging mass.

Counterbalancing the effective gain in mass will be a small decrease in velocity. In those 7 seconds, it may be slowed from 16 km/sec to perhaps 15.75 km/sec at the instant of impact.

Now comes the kicker. At this speed, even titanium behaves effectively as a liquid when it strikes a solid object. Equally to the point, any solid struck at such a speed also behaves as a liquid.

It splashes! The process is analogous to what happens if we take a drop of water about a foot above a plate with water on it and then drop it. Photograph the event in serial slow motion and we see first the momentary cratering of the surface water, then a central rebound accompanied by a corona of minute droplets being ejected from the sides of the impact.

In short, the higher I release the drop, the greater its kinetic energy and the higher the rebounding droplets will rise, with the smaller droplets achieving higher altitudes than the larger ones.

There is no need to go into the precise mathematics here. The results are pretty straightforward. Given the speeds cited as average, the impacting asteroid has the potential of ejecting 1.4 times its own mass back into space, providing the process is 100 percent efficient!

While 100 percent efficiency is a chimera, a 10 percent efficiency would make a highly acceptable average figure. In effect we could pretty well count on 9 to 11 percent of the asteroid's initial mass being ejected out into space. And the interesting point here is that little or none of this ejected mass would be residual from the asteroid itself. Virtually all of it would be ordinary terrestrial matter!

Material cast out as part of the central rebounding column will consist of molten globules which rapidly solidify but are often fragmented by impacts with other ejecta while still in a semi-molten condition. But the peripheral ejecta, the droplets in my earlier analogy, are basically intact and scarcely deformed. They simply weren't close enough to ground zero and lacked the time to be melted down. Nor would atmospheric friction be much of a factor in modifying the ejecta. The approaching asteroid has effectively cleared the atmosphere out of the way for a few critical seconds, so the same impact will create *two* types of meteorites; those which provide evidence of melting and resolidification and those which appear never to have been molten.

Given this, the casual assumption that nickel-iron meteorites represent core material from some demolished planet are probably premature. A minor asteroid impacting the old Mesabi iron ore range in Minnesota (which itself is possibly relict of some ancient asteroid strike) might easily produce duplicate ejecta.

So here we have the mechanism necessary to transport fragments of Mars or the Moon to Earth and the second of our three questions is answered. So far it has been pretty straightforward, but now things start getting more iffy.

What are we talking about when we try to determine the age of a meteorite? There are actually *four* different ages which interest the astronomer, and the news media almost invariably get it wrong.

Consider the problem. An asteroidal impact detaches a small chunk of matter from a planet and hurls it out into space. Later this meteorite successfully navigates its way through Earth's atmosphere and arrives at the surface reasonably intact.

First question. How old is the rock it-



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self? There is no *a priori* reason for it not to be older than our solar system; e.g., it may have been part of some earlier system which was blown to pieces when its parent star went supernova!

Do I believe this has happened? I doubt if it is a factor today, but it must have happened in the remote past. In general, probably most recovered meteorites date back one or more billion years. But not all do, and some appear to be only a few tens of thousands of years old.

Second question. How many years did the rock spend in space before it arrived on Earth? This is an even trickier question; one not always answerable with anything approaching a usable precision. Basically the age recovery technique focuses on the amount of cosmic radiation received during its sojourn in space, which may not be altogether accurate. For example, suppose a smallish asteroid was struck and disintegrated by a larger one. In the process fragments of rock from the interior were ejected and later found their way to Earth. Age dating could be quite skewed, simply because the interior was sheltered for so many aeons.

But this does not make it unusable. It simply means we have to treat the indicated age with some suspicion.

Third question. How many years did the meteorite spend here on Earth before it was recovered for science? This one is fairly easily answered for meteorites of greatest interest. Meteorites recovered in regions of Antarctica which are routinely patrolled by meteorite hunters are probably less than a year old. Those unearthed by some farmer's plow may be thousands of years old, but since they are mainly of passing interest, a more precise dating is seldom needed.

Of course, if five or six meteorites in a given region appear to share a common moment of touchdown, this is a signal for more intensive analysis. They may be part of a single parent body and minor differences in chemical composition could be of critical importance.

The fourth date is considerably more esoteric and not much can be done about it. This encompasses the weathering and other effects which occurred to the meteorite before it was shaken loose from its parent body. To illustrate the significance of the latter, many meteorites show clear evidence of having undergone melting and resolidification at some point in their history. Is this due to the kinetics of the asteroid impact which ejected them, or was there a prior molten phase such as might occur if the impacting asteroid penetrated a planetary mantle and ejected magma from the depths?

News media articles routinely cite ages without ever indicating what sort of age they are talking about. The results can prove highly misleading.

For my purposes here I shall consider only the time spent in space and ignore the rest. In general, most recovered meteorites appear to be a billion or more years old, but there have been a few with considerably lesser ages; a couple with ages measured in the thousands of years.

This brings me to the meat of the little problem. Whenever such a meteorite is found, astronomers routinely shop around until they find some astronomical body from which it might have been ejected.

But they tend to exhibit a rather myopic perspective. A given meteorite clearly came from outer space. It also shows demonstrable evidence of having been tooling around out there for tens of thousands or even millions of years.

So where did it come from? What body out there possesses a comparable albedo in the proper color distribution? If anything reasonably matching it is found we say "Voilà!"; it came from Mars, the Moon or wherever. If nothing is found, we call its origin unknown and leave it at that.

This completely overlooks the possibility that the meteorite was merely re-



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turning to its old home nesting ground!

When matter is ejected into space, one of two things must happen. If it has less than escape velocity, it necessarily returns to Earth. You can pretty well forget the myth about "accidentally falling into orbit around Earth." That scenario is so near to impossible as to be ridiculous. And this statement also applies to those theories which regard the Moon as having been ejected from Earth.

If it is thrown out with less than escape velocity, then its perigee must intersect Earth's surface. It goes up, then a short time (perhaps a maximum of 50 years, but more likely less than a week) later it comes back down.

If it is ejected with greater than escape velocity, then it is gone—but not necessarily for good. To escape from the solar system entirely, we would have to add an additional 50 km/sec to the escape velocity from Earth. While it is perhaps feasible to argue that occasional bits or pieces of ejecta may have been kicked out at such speeds, it is clearly impossible for significant quantities to have been accelerated that much.

This means the escaped ejecta must go into circumsolar orbit. And if it is not intercepted by some other solar system mass, then its orbit must either terminate at or cross Earth's orbit.

Since the ejecta is orbiting the Sun in a more elliptical track, the periods of the two bodies will be different. i.e., when the meteorite returns to intersect Earth's orbit, the Earth will be somewhere else, and the meteorite will be free to go its own way and continue circling the Sun.

Depending on the orbit, this may continue for millions of years. But sooner or later, the timing will be exactly right and the long-lost offspring of our Earth will come home to rest. And when it does, astronomers will no doubt look to Mars and elsewhere in hopes of discovering something new about our solar system.

As a pure hunch, I suspect that as many as a third of all recorded meteorite strikes may have originated on Earth.

Breaking them down by categories, I imagine that most of those believed to have come from the Moon actually came from the Moon. But then I also imagine that a relatively high percentage of Earth-ejected meteorites landed on the Moon.

Where I am most suspicious is with those meteorites whose origin is indeterminate, but whose elemental composition is consistent with Earth material which has been exposed to space for a few million years.

The Mars-origin hypothesis based on colorimetric analysis makes it likely that Mars was the point of origin, but the Earth is a big place and there is a finite possibility that the material we are looking at was ejected millions of years ago from a spot on Earth where the color spectrum is a rough match for that of Mars . . . some place akin to the Australian outback, the Vredefort of Africa, or even the Mesabi of Minnesota.

If so, then the proposed evidence of life may be a chimera and we are merely seeing a piece of what life was like at a given point on Earth at the moment of ejection. In short, the data from meteorites is interesting and fairly indicative, but in no way can be regarded as proof of any hypothesis. At best it offers a talking point for informed speculation.

So we are back on square one. We won't know until we get there. And when we do get there, we are almost certain to be surprised by what we find. ■

## About the Author

George W. Harper has written in a variety of fields, but has a special interest in articles about astronomy, focusing on ideas not in the textbooks. "About my only distinguishing characteristic," he writes modestly, "is a willingness to think outside the lines. . . . So far my batting average [on articles] has been pretty good, albeit anywhere between one and 25 years ahead of their time."



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Getting there may
or may not be half the fun. . . .

# The Rabbit Hole

James Gunn

*"Curiouser and curiouser!" cried Alice.*
*—Lewis Carroll*

They existed inside an explosion of light. It filled their waking moments and their dreams. They heard it as a background of white noise; they smelled it underlying a stench of human and machine effluvia; they felt it like the warp of their world; they ate it with their breakfast cereal.

The external viewscreens were blank. They had been turned off; nobody remembered who had done it or when. But they knew the glare was out there just beyond the walls of the ship. It was the only thing they knew for certain since they had entered the wormhole.

"No one knows what happens inside a wormhole," Adrian Mast said, turning in the swivel chair that faced the useless controls.

"Except us," Frances Farmstead replied.

They were inside the control room of the spaceship they had helped build. Although there was nothing to control, they found themselves meeting there as if by prearrangement. But that was impossible.

"If we really knew what was happening," Adrian said. "Or remembered from one encounter to the next."

"We should make notes."

"I've tried that," Adrian said. He wrote a note to himself on a pad of paper. He showed it to Frances. It read: *make notes*. "But I've never come across any record of anything I've written, on the computer or by hand."

"That's strange," Frances said, leaning back. "I'll have to try it."

"It's as if there is no before and after," Adrian said.

"It's a mystery," Frances said. She was seated in the swivel chair next to him. She was wearing loose-fitting khaki coveralls. Moments earlier, he thought, she had been wearing a kind of body-stocking. No, that had been Jessica, and it



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wasn't moments earlier. It had been before they entered the wormhole.

"We've got to solve it like a mystery," Frances said. "Like Ellery Queen or Nero Wolfe. Putting together clues."

"There's something wrong with that," Adrian said, "but I can't remember what. Maybe that's the trouble. We can't remember."

"We should make notes," Frances said.

"I'll try that," Adrian said. "What's the last thing you remember?"

"We had been accelerating for a long time, and then—and then—"

The crew had built the ship from alien plans. That was strange enough, but what was stranger was that the plans had been decoded from a message communicated in energetic cosmic rays picked up by SETI, decoded by a computer genius, and then smuggled to an incurious world disguised as a UFO cult book titled *Gift from the Stars*. Adrian had discovered it on a remainder table and recognized that the designs might work, and Frances had helped him track down the author, Peter Cavendish, only to find that he was in a mental institution. Just because he was psychotic, however, didn't mean that all his ideas were crazy. The ultimate bureaucrat, William Makepeace, took Cavendish's notions seriously, and, even though Makepeace tried to stop them, Adrian and Frances released the information to the world.

It didn't work out the way Makepeace feared, but it didn't work out the way Adrian and Frances had hoped, either. Rather than building a spaceship, the world used the aliens' antimatter collection process and engine designs to solve the energy problems of Earth, and once those were taken care of, most other human problems seemed to melt away. With Earth becoming utopia, nobody wanted to go into space any more, except for a few troublemakers. The Energy Board took ten years to see the wisdom of letting the malcontents depart, and the malcontents took five years more to build the ship. Then, when they started the engines, the ship began a headlong plunge into space controlled by a Trojan-horse program within the computer, inserted perhaps by aliens, certainly by Peter Cavendish. But Cavendish wasn't with them. He had been torn between his need for answers to the questions that once had driven him over the edge and the fear that the test flight would fail—or that it might succeed. In that paralysis of choice, he had stayed behind.

The immediate question was whether they should try to reprogram the computer to take back control of the ship. But where else would they go? If they continued toward an alien-chosen destination, they might find the answers to the other questions that had plagued them from the beginning: Why had the aliens sent the spaceship designs? What did they want from humans? What would humans find at the end of their journey, and what would happen when they arrived? If they arrived.

The ship had worked. Unlike most human designs—even though fallible humans had put the ship together, often from salvage—it worked the way machines and creatures in space had to work if they were to survive; that is, without a glitch. That nothing malfunctioned was due, as well, to Adrian's obsession with perfection, with his insistence on checking and rechecking everything. The ship had accelerated at one gravity past the orbits of Mars, of Jupiter, of Saturn, of Uranus, of Neptune, and finally of Pluto, and they had left the Solar System.

That took thirteen days. Moving beyond the Oort Cloud consumed another four hundred days. After a hundred days more of plunging into the abyss—a year and a half of living in enforced proximity to 200 other people, smelling their body odors, hearing their familiar anecdotes, speech patterns, and throat clearings, and eating recycled food—their



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tempers shortened and their anxieties grew. By that time Jessica Buhler had isolated Cavendish's program, and they had to fight the temptation to push the button that would put the ship back under their control and maybe cut them off forever from what had started them on this journey.

"I remember all that," Adrian said, rubbing his temples. "But what happened then?"

Behind them the Sun had dwindled into just another star, and although the stars were everywhere all the time, they could not escape the feeling of being far from everything that mattered. Then the blankness of space opened a blazing eye and glared at them.

"It was like a white hole," Frances said, "suddenly in front of us. . . ."

Conflicting gravities tugged at their bodies, as if all their loose parts wanted to go in different directions, as if their internal organs were changing places. . . . The glare was blinding. Jessica reached out with a hand that seemed to know what it was doing and slapped off the external viewscreens. The relative darkness was blessed, but the wrenchings continued. If time had existed, the sensations would have seemed to go on forever, but then the twistings and displacements stopped as if they had never been.

The odor of fear filled the control room.

"I think we're in a wormhole," Adrian said, as if that explained everything.

"What's that?" Frances asked. She was seated in one of the chairs in front of a panel that had been useless for control since the ship began moving. Now its readouts were gyrating wildly.

"Some kind of distortion in space. Physicists have said they could exist, in theory, but nobody has ever seen one."

"What good is a wormhole?" Frances asked.

"It's supposed to take us somewhere else," Adrian said. "We entered one mouth; presumably there's another somewhere and the two are connected through hyperspace. Physicists thought they would look like black holes but without horizons."

"It looks more like a white hole," Frances said.

"Some scientists speculated that the relative motion of the wormhole mouths would boost the energy of the cosmic microwave background into visible light and create a kind of intense glare."

"Too bad they'll never know they were right," Jessica said. She was standing between Adrian and Frances with a hand on the back of each chair.

"These things, these wormholes, they're everywhere?" Frances said.

Adrian shook his head. "Natural wormholes ought to be small and ephemeral. This one was created."

"Why would somebody create a wormhole?" Frances asked. She didn't like anything that she couldn't connect with something that she had read or seen.

"To get from one part of the Universe to another in a hurry. It may explain why Peter got a message in energetic cosmic rays. Sending a message over interstellar distances would have taken centuries, or millennia if the distances were really great. But if they were emitted from the end of the wormhole near the Solar System, the message would have arrived in less than a year. And whoever is at the other end could have used it to know we were here, maybe even keep track of us."

"Surely they couldn't see anything from here," Jessica said. "Even the Sun looked like just another star."

"They might be able to pick up energy transmissions, radio, television," Adrian said. "Maybe that's why they created it in the first place—because we started broadcasting back in the 1920s."

"This is so weird," Frances said. "Who could do something like this?"

"We couldn't," Adrian said. "Creatures



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far beyond our technical capabilities, maybe. What a physicist named Kip Thorne called 'an infinitely advanced civilization.' Damn! There's no 'maybe' about it. They did it, so they could do it."

"You said wormholes ought to be ephemeral," Jessica said. "This one seems to be persisting."

"So they not only had to create it," Adrian said, "they had to keep it from collapsing. Scientists think that would take something they call 'exotic matter,' something with negative average energy density, one of whose characteristics would be that it would push the wormhole walls apart rather than letting them collapse."

"Like antigravity," Jessica said.

"So what does it all mean?" Frances asked.

"We're inside something that doesn't belong to our reality," Jessica said, "and it is going to take us, if we're lucky, somewhere so far from Earth and our Sun that we won't even be able to identify them in the night sky."

"And if we're not lucky?" Frances asked.

"We could spend our lives in here," Jessica said, "or have it collapse with us inside it, which might strand us in hyperspace, if we survived. I think that would be pretty bad."

"That's about it," Adrian said absently. He was looking at a pad of paper.

"What's wrong?" Frances asked. "Besides being lost."

Adrian showed them the pad. On it someone had written: *make notes.*

"Seems like a good idea," Frances said.

"Sure," Adrian said. "But I didn't write it. That is, I don't remember writing it. I remember that I will write it." He looked confused.

"I remember that," Frances said. Her voice was excited. "But it won't happen—"

"What's going on?" Jessica asked.

Adrian drew a square around the words on his note pad and then constructed a square on each side. "Space is different inside a wormhole. Maybe time is, too. Space and time are part of the same continuum. We may be in for some strange effects. At some point, for instance, I'm going to say 'It's as if there is no before and after.' But that's wrong. The before may come after the after."

"Like remembering what hasn't happened yet?" Frances said as if she were making a joke.

"And maybe not remembering what has already happened," Jessica said.

"'It's a poor sort of memory,'" Frances said, "'that only works backward.'"

"Why does it sound like you're quoting from something?" Jessica asked. "Aside from the fact that you're always quoting from something."

"It's from *Alice in Wonderland,*" Frances said. "Or rather from the sequel, *Through the Looking Glass*, and the reason it comes to mind is that, like Alice, we've fallen into a rabbit hole, and in Wonderland everything is topsy-turvy."

"I don't think we're going to find any answers in children's stories," Jessica said.

"I've always found Frances's fictional precedents helpful," Adrian said.

"The point is," Frances said, "that we're going to experience something that is likely to make us crazy unless we have something to cling to."

"Like what?" Jessica asked skeptically.

"When Alice fell down the rabbit hole, she encountered talking rabbits, and caterpillars that smoked, and cats that disappeared, and who knows what all. Maybe we're going to run into the same sorts of things. If we can treat it like a kind of wonderland experience, meeting the strange but not surrendering to it, we can cope."

A patter of feet came from beyond the hatchway that led to the rest of the ship. Frances and Jessica looked at each other and then at Adrian.

"That sounded like children," Jessica said.



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"'Curiouser and curiouser,'" Frances said.

In the middle of the night, Adrian heard a rustling sound and something that sounded like a sigh. He pushed the switch beside his bunk, and overhead light flooded the tiny room. Jessica was standing just inside the open door, one arm out of the body stocking that was all she wore and the other arm halfway removed.

"What's going on?" Adrian asked, sitting up so suddenly the room spun around him.

"I didn't want to wake you," Jessica said.

"I mean, what are you doing in my room?"

Jessica looked around, as if the question that Adrian had asked was being processed. "I don't know. It seemed—natural," she said. "But now I can't remember why."

Adrian looked at the portions of Jessica's body that had been revealed: the smoothness of her skin and the curvature of what seemed, under most circumstances, athletic and slender. It was as if he was seeing her for the first time as a woman instead of a member of the crew.

"It's this damned wormhole," Jessica said, shrugging her arms back into the body stocking and closing the top with one stroke of her right hand.

But it wasn't the same as it had been before. Maybe it was because he had no imagination, Adrian thought, or maybe because his imagination was focused on distant goals, but now that he had seen Jessica as a woman it was difficult to see her as anything else. But he would, he knew; the wormhole would see to that.

"What's going on in here?" another voice asked from the doorway. It was Frances, solid and square in her pajamas, almost filling the space. The room was so small that she was standing next to Jessica.

"That's hard to say," Adrian replied.

Frances looked from Adrian to Jessica and back again. "Doesn't look that difficult to me. If this were a romantic film, the next scene would show lovers springing apart guiltily, or waking up together. If this were a suspense film, they would be plotting some kind of caper. If it were a mystery, one would be planning to kill the other."

"It's a farce," Adrian said.

"People wandering into each other's rooms without any reason and finding themselves in embarrassing circumstances," Jessica said.

None of this eased Frances's air of suspicion. "Oh, there's a reason. There's always a reason."

"You forget our wormhole inversions," Adrian said. He had his feet planted firmly on the deck.

"Whatever the problems we're having with cause and effect," Frances said, "a midnight meeting doesn't happen by accident." She frowned at Jessica as if they were in a contest and Jessica had broken the rules.

"I admit it looks suspicious," Jessica said, "but I wasn't trying to seduce Adrian."

Adrian flinched. The deck didn't seem so firm.

"It just seemed natural," Jessica said.

"Of course it did," Frances said.

"You know what I mean. Not something that was planned. God knows we can't do that inside this damned hole. Just something that seemed as if it had happened before."

"I'm not surprised," Frances said.

"If it did," Jessica said.

"And it didn't," Adrian said.

"You keep out of this," Frances and Jessica said almost simultaneously.

Adrian looked from one to the other. Frances started laughing. "You look like Cary Grant in *The Awful Truth*." Then her expression sobered. "We really need to come to an understanding."

"I know," Jessica said. "If we get out of this place, we're going to need children."



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"They don't have to be his," Frances said. "There are lots of other men."

"We can't afford to waste any genetic material," Jessica said. "Chances are we'll never get back. Or if we get back, it may be in the remote past or the distant future. We may be all that's left of the human species. All of spacegoing humanity, anyway."

"That's as may be," Frances says. "But what's to say I couldn't have children."

"No reason you couldn't," Jessica said. She put her arm around Frances's shoulder. "We've got doctors and we downloaded to our computers all the medical information available. Your uterus might not be up to the pregnancy bit, but your ova may well be harvestable."

"Thanks," Frances said. "But there's the emotion part."

Jessica hugged Frances harder. "We're going to have to get over that part. There's too much at stake."

Frances smiled and put her hand over Jessica's. "That's settled then. I'm glad we had this talk."

Jessica smiled back. "Me, too. I just wish we could remember it later."

Adrian looked from one to the other. "Wait a minute! What's going on here?"

"None of your business," Jessica and Frances said together.

"Come on, now," Adrian said, feeling confused and maybe frightened. "You're disposing of me like a prize cow—"

"Bull," Frances said.

"And you say it's none of my business?"

Frances reached over and patted Adrian's hand. "Don't worry! It will all work out. You take care of getting us out of here. We'll take care of the social arrangements."

Adrian looked from one woman to the other. "How are we going to get out of here?"

"You'll figure something out," Jessica said.

From outside the tiny captain's quarters came the sound of children's voices raised in some kind of game, but when Frances turned and Adrian reached the door, the corridor outside was empty.

When Adrian entered the control room, someone was seated in the chair that faced the prime computer station. That wasn't unusual—or at least it wouldn't have been unusual if the usual had existed as a comparison. What was unusual was that the head was familiar, and it should have been back in Earth orbit or, by now, back on Earth. But everything operated by different rules inside the wormhole, and the key to sanity was not trying to apply rules appropriate to normal existence. The person wasn't computing; it seemed to be reading a book.

"Peter," Adrian said. "What are you doing here?"

The chair turned. The person was Cavendish without a doubt, looking as real as Adrian, as solid as Adrian. "Same thing you're doing," Cavendish said. "Trying to find a way out of here."

"We left you back in Earth orbit," Adrian said reasonably.

"I remember that, too," Cavendish said. "Yet here I am."

"I don't think so," Adrian said. "I think you're some kind of illusion." He took a step toward Cavendish as if to confirm the existence of the other man by touching his shoulder.

"I wouldn't do that," Cavendish said.

"Why not?"

"If your hand passes through me, you're going to think your mind is going. If you find out I'm solid, that I'm really here, you're going to question your grasp on reality."

"You're the one who's supposed to be paranoid."

"And I'm not worried?" Cavendish shrugged. "Maybe that means I'm not really here. Or that what's here isn't really me."

Adrian went to the captain's chair, sat down, and swung around to face Cavendish. "Why are you here?"

"Things haven't worked out, have



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they?"

"That depends on what things you're talking about. The ship took us to this wormhole. That worked out. I gather that you programmed that into the computer."

"I just downloaded that part of the message."

"The part you didn't tell us about."

Cavendish shrugged. "It wasn't something I could share without creating crises of decision."

"So you made the decision for us."

"I didn't know that it would take the ship here. All I knew was that this was what the aliens wanted."

"They could have wanted to blow us up," Adrian said.

"If they didn't want us out here in spaceships, they wouldn't have sent the designs. It would have been a sorry joke to send the designs, with the antimatter technologies and everything, and have a few humans spend years building a ship just to destroy us."

"Then why didn't you come along?" Adrian asked.

Cavendish shivered. "You see? I am paranoid after all. I was afraid to go and afraid not to go. I was afraid not to have answers and afraid of the answers I might get. But I had to get some answers, even if only by proxy, and the only way any answers would emerge—although I would never know what they were—was by sending you to get them."

"Thanks," Adrian said.

"They were your answers, too," Cavendish said.

"OK," Adrian said. "What hasn't worked out, then?"

"The wormhole. Passage should be instantaneous. But the ship is still inside."

"If we knew what 'still' meant. Time doesn't exist as we know it, in the wormhole. We've found that out, though it's hard to remember. So whatever is happening, in whatever order, or in no order at all, may be happening in the instant we went into the wormhole and the following instant we emerge from it."

"On the other hand," Cavendish said, "this may be a test."

"What kind of test?"

"A test of sapience. Like we're test rats in mazes. Maybe picking up the alien message was a test, and deciphering it was another, and getting to build the ship was a third, and building it so that it worked was another. This wormhole may be our maze, and if we don't do anything, we may never get out."

"And if we get out," Adrian said, "what's our prize?"

"That's the big question, isn't it? That's what drove me into the protection of psychosis in the first place. Maybe the prize is a bit of cheese—or what cheese represents to a rat."

"More gifts like the antimatter technologies?"

"Or maybe aliens hungry for a different delicacy."

"Welcome to the galactic civilization?"

"Or insanity as we try to cope with the truly alien."

"Whatever it is," Adrian said, "we aren't going to know until we get out of here. Do we do nothing and hope that eternity comes to an end? Or do we do something—anything—in the hope that it's the right thing?"

Cavendish looked uncertain and a bit fuzzy around the edges. "I don't think it would be a good idea to do anything until you have a good idea it will work."

"That's the trouble in here," Adrian said. "Not only is it difficult to make plans—it's difficult to figure out causes and effects, when the effects come first and the causes later."

"'Sentence first, verdict afterwards,'" Cavendish said.

"You sound like Frances."

"There's a bit of Frances in me," Cavendish said. He was beginning to look transparent. "Just as there's a bit of you and of Jessica and maybe a tiny bit of me."

"I'd make a note of all this if I knew



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what you were talking about," Adrian said.

"And if you could find it after you wrote it."

"How do you know about that?" Adrian asked. He watched Cavendish's wispy form waver in the slight breeze from the air vents. Gradually the various parts of him began to disappear, first the feet and the hands, then the legs and the arms, and finally the torso, beginning at the hips.

"I'm not really here, you know," the ghost of Cavendish said. "You're really talking to yourself." His body had faded completely, and now only his head hung unsupported in the air.

"Some things you've said I didn't know," Adrian said.

"Nothing you haven't guessed or speculated about," Cavendish said. Now there was only a mouth. But it wasn't smiling. The corners were turned down in Cavendish's typical paranoid grimace.

Then he was gone. Adrian told himself that he would ask Frances what it all meant—if he could remember.

He looked down at the computer table. Cavendish had been reading *Gift from the Stars*.

The knock came on the door of the captain's cabin as Adrian was going over the computer readouts once more, searching for an answer that he would forget if he found it. Adrian had not wanted to occupy the captain's cabin—more of a cubbyhole, really, like the ultracompact quarters on a submarine. He preferred to bunk with the others in the unmarried men's dormitory, leaving the only private accommodation on the ship for the privacy of conjugal visits, but the crew had insisted. Partly, he thought, out of their own sense of propriety.

"Come in," he said, putting the book he was reading on the surface that passed for a desk when it was pulled down, and turning on the stool that passed for a desk chair when it was not folded into the wall.

The air-tight door slid aside. Jessica was standing in the narrow corridor, fidgeting from one foot to the other, looking concerned. That was nothing different. They all were.

"Do you have a moment?" Jessica asked.

Adrian gestured at the read-out. "That's all any of us have."

Jessica sidled into the room and sat on the edge of the bunk. Her knees were only a few inches from Adrian's and that was uncomfortably close. "We've got a problem."

"I know. Not only are we in a reality where the normal rules don't apply, where even the laws of physics seem to be different, we can't make plans because we don't remember anything from one series of related events to the next."

"As long as events have some continuity," Jessica said, "they seem to hang together, pretty much, one following the other in before-and-after sequence. It's when the continuity is broken that causality is suspended."

"Or reversed," Adrian said. "We do remember things that haven't happened yet. So maybe what we have to do is to lay the groundwork for what we will remember earlier. At that point, maybe, we will know what to do and be able to do it."

"Which, of course, would get us out of this place before we had a chance to lay the groundwork necessary for the proper decision."

Jessica was sharp and a hard worker—in fact, she was his most reliable assistant. He knew this voyage would never have started without her, and it was likely that it wouldn't continue without her either. "I know," he said. "It's crazy. But what we have to remember is that what makes sense is probably worthless and only the right kind of nonsense will work."

She leaned forward to put a hand on his knee. "But that isn't why I'm here."



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Adrian shivered. It wasn't that he didn't like to be touched. Frances put her arm around his shoulder and hugged him. Other crew members patted him on the back and shook his hand. This was different. He didn't want to think about what made it different.

"We haven't had any time for personal matters," Jessica said. "We've been too busy with building the ship. Now we've got nothing but time until we find a way to get out of the wormhole."

"Yes, time," Adrian said. He couldn't think of anything else, anything that would stave off what he feared was coming. He could make decisions about life and death but he wasn't good at what came between.

"We're a band of humans split off from the rest of the species, and there's little chance we'll ever get back."

Adrian nodded.

"So," Jessica said, "we've got to think about survival."

"That's all I think about."

"Not just us. The little band. What we stand for. The human species in space."

Adrian cleared his throat. The room was getting stuffy. "Yes?"

"We must make arrangements."

"Arrangements," Adrian said.

"We've got to pair off. We need to think about having babies and the gene pool and everything else."

"Everything," Adrian repeated.

"I know you don't like to talk about things like this, or think about them either," Jessica said. "So we women have to think about it for you, make plans, arrange things."

"You mean you've discussed this?" Adrian said huskily. "You and the other women?" He realized that he sounded incredulous, but he couldn't help himself.

"Of course not," Jessica said. "But we know. And I wanted you to know that I've always admired you, as a leader and as a man. Not only that, I like you." She leaned forward and kissed him.

For a moment, surprised, he responded. Her lips felt soft and sensual. Then he drew away, shocked at the way his body had responded.

Jessica stood up. Suddenly he was aware of the fact that underneath the one-piece garment she was wearing, only a foot from his face, was the body of a woman, and it was the body of a desirable woman, and if he understood what was going on, it was his if he wanted it.

"I'm glad that's settled," she said, leaned down to kiss him on the cheek, and went through the doorway and down the hall.

"Settled?" he said, too late to be heard. "Settled?" He had one saving thought: at least all this would be forgotten like everything else.

He thought he heard laughter somewhere down the hall, but it came from voices he had never heard before.

Adrian wasn't good at talking to groups, but Frances had said it was necessary and he knew that was true. If he had been depending on someone else to solve the problem, he would have been as traumatized as the crew by the time reversals of the past two hours, not to mention the gravity wrenchings of the wormhole transition. They had been forgotten, but Adrien knew they must have happened. He was puzzled, too, but he was in charge. That meant whatever was done would be done by him, and, moreover, he couldn't appear to the crew the way he really felt—helpless.

He had gathered the crew twice before, the first time before the test flight, when he had offered the opportunity to depart, unobserved, to anyone who wanted to sit it out. The second meeting had discussed the computer program that was guiding the ship out of the solar system, and the reasons for allowing the course to continue toward what they assumed to be an alien-selected destination.

After that, the crew divided itself into groups—work groups and social groups,



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which were not always the same. The crew had been assembled from volunteers to build a ship; once that was done, it had to discover new skills and new interests. At first, that shakedown was enough to fill the hours. Later, squabbles arose about social arrangements and romantic pairings that had to be settled by counseling from Frances or, failing that, a ship's court, and if that was not acceptable, an appeal to the Captain's final review. Now, however, he had to face them all and explain the inexplicable.

They were gathered in the couple's dormitory, which had been the unmarried men's dormitory before the inevitable pairings had led to the switch. As in the two times before, men and women were seated on bunks or stools, or stood wherever they could see Adrian. Frances stood behind Adrian and to his left, providing the support of her solid presence. Jessica, on the other hand, stood by the door as if guarding the avenue of their escape. The climate in the room had been transformed from the intense boredom of space flight, broken periodically by personal successes, disappointments, and disputes, to a communal unease broken by moments of panic.

"We knew we would encounter some strange phenomena out here," Adrian said. "But we didn't know it would be this strange!" The crew responded with a nervous chuckle.

"We have been through an experience that defies explanation," Adrian continued. "It is connected to our entering a wormhole. We know that much. We must have felt some gravity fluctuations."

"Why do you say 'must have'?" a man's voice asked from several bunks back.

"That's what we would expect from a wormhole, George," Adrian said, "but we're still here, so we survived them. If you're like us, however, you don't remember."

"I don't remember anything that happened after we entered whatever it was," another man said. "And that scares me!"

"It's enough to scare anybody, Kevin," Adrian said.

"There's something else," a woman said. "I'm remembering things that never happened, like an argument Bill and I had—are going to have."

"And I remember the way we are going to make up," a man answered. He laughed as if he were pleased with himself.

"We've got a theory about that," Adrian said. "You're remembering things that haven't happened yet because time is mixed up in here. But we can't let the unusual get to us if we're going to figure out what's going on, and get out of this place."

"When's that going to be?" a woman asked.

"We don't know a lot, yet, Sally," Adrian said, "but we know this much: 'when' is a word that doesn't mean much where we are. A wormhole is an out-of-this-world means of getting from one place in the Universe to another, like folding space so that distant points touch and crossing there. The wormhole exists in some kind of hyperspace where space and time get mixed up. We think—"

"Why do you keeping saying, 'we think'?" a woman asked nervously.

"This all is new and different, for us as well as you, Joan," Adrian said. "Give us a chance to figure this out, how this new kind of time operates and how we can function within it, and, I assure you, we'll get out of here and on our way."

Frances spoke up. "You might think about *Alice in Wonderland* and *Through the Looking Glass*. Alice was in a place where nothing made sense, but she stayed calm and eventually she got back to her safe, sane home."

"This ain't a children's book!" a man said. "And this ain't fiction."

"Sam, I hope we can be as capable of



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handling the unknown as a Victorian child," Frances said. "Maybe we'll even get some answers."

"We ain't never going to get back, are we?" a woman said.

"We can't be sure of that yet, Lui," Adrian said.

Jessica spoke up for the first time. "But we've got to behave as if that's true, or we've got no chance at all."

"What I want to know," a woman said, "is where 'on our way' is going to take us."

"We don't know, Yasmine," Adrian said. "But we all signed on to have our questions answered, and we're going to have to follow the yellow brick road wherever it leads us until we get the answers."

A man said, "What's 'the yellow brick road'?"

Adrian smiled. "Frances has me doing it now."

"That's another children's book," Frances said.

"I'd rather come up with my own answers," another man said.

"If you come up with any, let me know," Adrian said. He folded his arms across his chest. "Meanwhile, we're going to have to live with uncertainty and forgetfulness and not let it make us crazy. But there's a way out of here. The wormhole was a confirmation that we are headed in the right direction. What we can be sure of is that we weren't directed here simply to strand us in Wonderland. This is a pathway. We just have to figure out how to move along it."

"'Moving along it' reminds me," Frances said, "of what the chess queen said to Alice in *Through the Looking Glass:* 'Now here, you see, it takes all the running you can do, to keep in the same place. If you want to get to somewhere else, you must run at least twice as fast as that.'"

"What's the good of that?" a man asked gruffly.

"We don't know, do we, Fred?" Frances said. "But I have a memory that it's going to matter. Oh, dear! That doesn't make sense, does it?"

"Frances, you're always finding a moral somewhere," a woman said.

"'Everything's got a moral, if you can only find it,'" Frances quoted triumphantly.

Shortly after that the meeting ended, with the crew informed but not relieved. For the moment, at least, they were not rebellious. Adrian had the uneasy feeling, however, that something about the meeting wasn't right: the room was more crowded than it had ever been before.

But he promptly forgot.

Adrian was alone in the control room when the deputation arrived. Three were men; two were women. All of them were young and all about the same age, late teens, maybe, or early twenties. In their youth and energy, they looked a lot alike. One of the men and one of the women were blond; two of the men were dark-haired and one of them was dark-skinned; the second woman had dark hair. Adrian had never seen them before.

The dark-haired woman reminded Adrian of Jessica. One of the men looked familiar, too, but Adrian couldn't quite decide whom he looked like.

"We're here to present our demands," that young man said. His voice sounded familiar, too.

Adrian tried to keep from flinching. "Who are you?" he asked.

"You know who we are," the blond girl said.

Adrian shook his head. "You're all strangers. And the strangest part is that we're in a wormhole inside a ship that nobody can leave and nobody can enter."

"We're the next generation," the woman said.

Adrian was seated in the captain's chair. The five newcomers formed a semicircle around him, lithe, athletic, and leaning slightly forward as if they



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were poised to take him apart. "We've been here that long?" Adrian asked.

"Duration is a word that has no meaning," the first young man said.

"It's hard to break old habits," Adrian said.

"We don't have any to break," the other dark-haired young man said. He sounded bitter.

"We agreed to keep this civil," the first young man said. He looked back toward Adrian. "We're here to present our demands."

"You've got to let me get used to the idea that the crew has had children who have grown up while we have been stranded in a wormhole that was supposed to provide instantaneous passage. I don't feel twenty years older."

"That's old-fashioned thinking!" the other blond young man said contemptuously.

"He can't help it," said the young man who appeared to be the spokesman for the group, if not, indeed, its leader. "He's system-bound."

"He's got to help it," the blond young man said. "He's the captain."

"How many of you are there?" Adrian asked.

"Many," the blond young woman said.

"Enumeration is as difficult as duration," said the spokesman.

"Are you all the same age?" Adrian asked.

"You see?" the young man asked. "He'll never learn."

"Sometimes yes, sometimes no," the spokesman said patiently. "None of these questions you're asking have any meaning unless we get into normal space. And that's what we've come about."

"To present our demands," the blond young woman said.

Adrian folded his hands across his lap. "I don't know what you can ask for that we can provide, but go ahead."

"We want you to stop trying to get out of the wormhole," the spokesman said.

"We can't do that!" Adrian said.

"Why not?" the young man said.

"We're in never-never land," Adrian said. "Nowhere. No memory. No continuity. Virtual nonexistence. And then, you see, we committed ourselves to finding out why the aliens sent us the plans for this ship and brought us here." He gestured at the book lying in front of him; it was *Gift from the Stars*. Often he found himself reading it as if he could find there a way out.

"We didn't," the bitter young man said.

"Didn't what?" Adrian asked.

"Sign up for this trip."

"But—" Adrian began.

"You've got no right," the spokesman said, "to take us somewhere against our will."

"And against our right to exist," the dark-haired young woman said.

"What's that?" Adrian asked.

"What do you think will happen to us if you get out of this wormhole?" the spokesman asked.

Adrian was silent.

"We won't exist."

"What kind of existence is that?" Adrian asked finally. "What is life without memory? What is existence without cause and effect?"

"The only kind we know," the bitter young man said.

"We are your children," the spokesman said. "You brought us into this world, crazy as it seems to you. But it's our world, and you owe us."

"He also owes the rest of us," a woman said from the door. It was Frances. "And the species. If you're more than illusions, you'll be born at the right time in the right place. But now—be gone. You're nothing but a pack of possibilities."

The five turned toward her, frightened and uncertain, and disappeared like snowflakes evaporating before they hit the ground, leaving their potentials etched into the air.

Adrian rubbed his forehead. "They were so—real. So like the children the



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crew might have had—might have. Our language wasn't meant for in here."

"One of them looked like Jessica," Frances said.

"And another one—" Adrian began and stopped.

"What?"

Adrian looked into one of the darkened vision screens. There were no mirrors in the control room, but he could see his reflection. He knew who the spokesman for the group looked like.

He looked like Adrian.

A familiar figure with a familiar walk and a familiar look to the back of the head turned at the far end of the corridor and, before Adrian could speak, disappeared down the side corridor that led toward the mess hall. It was a man. Adrian was sure of that. "Hey!" he called out, but by the time he reached the corridor it was empty. Only Frances was in the mess hall, cleaning the table that doubled for conferences, and she looked puzzled when he asked if anyone had just come in or passed.

But when Adrian returned to the corridor leading back toward the control room, he saw the same figure in front of him. He ran toward it, but it got farther away the faster he ran. By the time he got to the control room, it was empty. He went back down the corridor, trying to figure out what it meant. When he turned to look behind, he saw the back of the figure again, still moving away. This time Adrian turned and went the other direction, and came face to face with the man just outside the mess hall.

"Adrian!" they each said. Then, "I don't believe it!"

"We'd better speak one at a time," Adrian said.

"I agree," Adrian said.

"We've got to decide, first, who's the real Adrian and who is the doppelgänger," Adrian said.

"I'm real," they said together.

"Look," Adrian said, "this isn't getting us anywhere. I'll tell you what. As Frances would say, "'If you'll believe in me, I'll believe in you.'"

"That sounds reasonable," Adrian said. "Maybe this is the opportunity we've been looking for—to find a way out of this place. Let's go in here and talk about it."

Adrian nodded. "We can put our heads together."

And Adrian added, "Two heads are better than one."

When they entered the tiny mess hall, Frances was gone. Adrian didn't think enough time had passed for Frances to have completed her clean-up and departed. He didn't know whether that meant he was in his doppelgänger's reality or whether it was another example of the wormhole's vagaries.

"Obviously," Adrian said, seating himself on a stool at the table, "the time variables have us tied up."

"Obviously," Adrian said, leaning back against one of the microwaves, not wanting to put himself in a mirror-image position. "But what isn't obvious is what we're going to do about the fact that we only remember what happens later."

"That's true," Adrian said. "So the secret is to prepare later for what we need to know earlier."

Adrian nodded. "I've thought of that. At least I think I've thought of that. The difficult part is remembering that we have to store information for earlier use."

"We have to come to that realization independently, every time. We have to learn to think differently, just as we have to learn to think differently about Jessica and Frances."

"What do you mean?" Adrian asked.

"It's clear to me, and it should be clear to you, that both Jessica and Frances are fond of us."

"And I'm fond of them," Adrian said.

"One, or maybe both, are going to want that relationship to get even closer."

Adrian nodded. "That's an uncomfortable thought, but if it happens I will



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have to handle it."

"When we 'handle it,' as you say, we will have to think in unaccustomed ways."

"I know," Adrian said.

"I don't mean just the business of allowing emotional involvement, even intimacy, but the possibility of sharing, or being shared."

Adrian took a deep breath. "I understand you. What am I saying? I am you."

"In the same way," Adrian said, "we are going to have to think about our physical predicament in unconventional ways. Logic doesn't work."

"We'll have to try illogic," Adrian said. "As a matter of fact, I've already tried it. I caught up with you by going the other way."

"I was the one who caught up with you," Adrian said and then waved his hand. "No matter. We'll have to think impossible things."

"As Frances would say, 'I can't believe impossible things.'"

"'I dare say you haven't had much practice,'" Adrian continued. "'When I was your age, I always did it for half an hour a day. Why, sometimes I've believed as many as six impossible things before breakfast.'"

Adrian moved from in front of the microwaves. "I'm glad we had this meeting, even though it was a bit of a shock." He didn't offer to shake hands with the other Adrian. That would have been too much. "But I hope it doesn't happen again."

He went through the doorway into the corridor. This time he didn't look back.

They all knew it was time to act. Jessica looked at Adrian, Adrian looked at Frances, Frances looked at Jessica. They had been in the wormhole too long. None of them knew how long it had been: days, weeks, maybe even years. But they knew that if they didn't do something soon they would never get out.

Jessica looked at the gyrating readouts on the control panel. "We have to know what is going on outside," she said.

"None of our instruments work," Adrian said. "Or if they work, they aren't recording."

"We could turn on the viewscreens," Frances said.

"We've tried that. All we see is glare," Jessica said.

"That's the cosmic microwave background boosted into visible light," Adrian said.

"I think the viewscreens are as unreliable as the readouts," Jessica said. "We try to cut back on the light, and the screens go black. Somebody has to go outside and report."

Adrian nodded. "I agree. And I'm the only one who is capable of making sense of what is happening. I'll get ready."

"You can't be spared," Frances said. Her face had that "there's-no-use-arguing-with-me" look.

"Frances is right," Jessica said. "I'm the most experienced in working on the outside, the youngest, the most athletic, the steadiest—"

"You can't be spared either," Frances said. "You're young, all right, and you have a life ahead of you if we ever get to a place where you can live it. That leaves me."

"There's radiation out there," Adrian said. "God knows what. Even if it isn't fatal, whoever goes out there is going to take a lot of damage."

"Besides," Jessica said, "you get sick just turning your head quickly."

"I can do this," Frances said. "I can do whatever I have to do. And you've got a young body and young ova—all that needs to be preserved if we're going to have a future." She stood in front of them both, in the control room, square and ready.

"I'm not going to talk you out of this, am I?" Jessica asked.

Frances shook her head. "In a movie,



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you'd hit me on the head and take my place, but this isn't a movie and it isn't going to happen."

"I'm glad you know the difference," Adrian said. "No heroism."

"Just common sense," Frances said. "Now I need some help getting into a suit." She smiled at her admission of inadequacy.

Spacesuits had not been built for someone as short and wide as Frances, but a man's suit had been adapted by removing sections of the leg and welding the remaining pieces together. That didn't help Frances's agility, but then she hadn't used the suit much. Now she struggled into it, and Jessica checked all the closures twice.

"Don't stay out there more than a minute or two," Jessica said, "and don't try to do more than a simple survey. Be sure to snap yourself to the interior hook and make certain your magnet is firmly attached to the outer hull before you—"

"Hush," Frances said. "You're only making me nervous."

She turned and hit the large button beside the inner hatch. It cycled open as Frances turned, patted Jessica's shoulder with her glove, and touched Adrian's hand. She adjusted her helmet and stepped over the sill into the airlock.

Jessica spoke into her head-held microphone. "Can you hear me? Be sure you keep your mike open all the time. I'm going to suit up so that I can come out and get you if you're in trouble."

Frances shook her head inside the helmet as she pushed the inner button and the door began to close. "We don't want to lose two of us," she said. "Don't worry. If I don't get back, it's been a great run." But her face looked pale before the door completely closed. "I'm opening the outer hatch. God, it's bright out here!"

Jessica looked at Adrian, and Adrian looked back, but their thoughts were outside. "What's going on?" Adrian asked.

"I'm darkening my face plate. There, that's better."

"What can you see?" Jessica asked.

"Wait a minute. I feel a little sick. There's nothing to look at."

"Frances!" Jessica said. "Look at the airlock. Look down at your feet. Then look at the ship. Orient yourself to the ship!"

"Got it!" Frances said. "The ship seems to be moving. I can see some kind of disturbance in the glare that might be exhaust, so the engine is still operating, but we knew that, since we've had gravity."

"Which way are we going?" Adrian asked.

"Hard to say," Frances said. "There seems to be a dark place in the glare."

"Which direction?" Adrian asked.

"Toward the rear of the ship," Frances said triumphantly. "Where the antimatter stuff comes out."

"That must be the mouth of the wormhole where we entered," Adrian said.

"That's enough," Jessica said. "Come in."

"Not yet," Frances said. "I'm looking around while I'm here."

"Don't look around!" Jessica said.

"Funny stuff out here," Frances said. "A weird-looking contraption just went by. All twisted pipes and girders. Speak of ships that pass in the night!"

"You're not doing us any good out there," Adrian said.

"There's another ship, or vehicle, or something," Frances said. "Only it's like a stack of waffles with a flagpole through the middle."

"Frances!" Jessica said. "You're making us nervous."

"Goodness knows, you've made me nervous often enough," Frances said. "There's an alien, I think. A creature of some sort with tentacles. And one shaped like a cone with eyes. And another, and another!"

"You're losing touch!" Adrian said. "Come back! Now!"

"There's the Mad Hatter!" Frances



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shouted. "And Humpty Dumpty. And the caterpillar smoking the water pipe. And the Queen!"

"Come back!" Jessica said softly. "Come back, Frances!"

"Off with their heads!" Frances said.

Adrian looked at Jessica. She turned and began climbing into her spacesuit.

"Remember," Frances said. "You have to run twice as fast as that!"

Something clanged from outside the ship, like a magnet being freed and metal-shod feet pushing against the hull.

Jessica stopped halfway into her suit. "I knew I should have gone," she said.

Adrian shook his head. "There's no way we can go faster," he said. "But maybe we can make Frances's sacrifice meaningful." He didn't know how that was going to happen, but, as unshed tears burned his eyes, he knew he would make it happen.

Jessica slapped the viewscreens back on and let the glare fill the control room. "We've got to do something. Frances has—is going to—oh, I don't know what the right tense is. But she has given us all the information we're likely to get, and she's dead—surely she's dead."

"There's not much doubt about that," Adrian said. "We're remembering things that have yet to happen, including things that might happen, and we've got all the memories of what has yet to happen that we're likely ever to get."

"Even though we've just entered the wormhole," Jessica said.

Adrian nodded. "That's the funny way time works in here. Now we know, but later on we'll forget. So we've got to do it now."

"Frances said we had to run twice as fast," Jessica said.

"And I said there was no way to do that," Adrian said, "or any reason to think going twice as fast would get us anywhere." He looked around at the control room. In spite of the glare, for the first time he was seeing things clearly; Frances, Jessica, the aliens and their plans. "We've been trying to reconcile the unreconcilables, the time anomalies, or our own inability to adjust to inversions and potentials."

Jessica looked at him hopefully, the way an apprentice looked at her master, anticipating wisdom.

"We've got to turn the ship around," Adrian said. He turned to the controls. "Go back the way we came. If we were in real space, we'd have to decelerate for as long as we've accelerated, but this is hyperspace and we haven't moved far from where we entered."

"Let me do it," Jessica said. She began punching instructions into the computer. "But isn't that just giving up?"

"Maybe," Adrian said. He tried to isolate a cold feeling in the pit of his stomach. Maybe it was giving up. "Logically we should come out the way we came in, and then everything will have been for nothing—all our psychological torment, the felt years of experience, Frances's sacrifice—"

"But maybe not?" Jessica said.

Adrian could feel the ship swinging even though there was nothing to see, no way to get information from gauges, nothing but glare. . . .

Something surged.

Conflicting gravities tugged at their bodies, as if all their loose parts wanted to go in different directions, as if their internal organs were changing places. . . . Then the glare and the gravity fluctuations stopped suddenly. Adrian and Jessica looked at each other, remembering everything that had happened or might have happened inside the wormhole. They turned to look at the viewscreens. The glare was gone. Outside was the blackness of space with here and there the pinpoint hole of a star. It could have been anywhere in the galaxy including back near the spot from which they had been drawn into the wormhole.

Jessica adjusted the controls and new arenas of space swam into view. The stars were few and distant. A single star loomed closest, but it was old and faint.



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"That isn't our solar system," Jessica said. "That isn't our sun."

Adrian shook his head. "Wherever we were going, we've arrived."

"How did you figure it out?" Jessica asked.

"If time was inverted," Adrian said, "maybe space was, too. In order to get out, we had to reverse our course. But then, I had some help." He thought about the other Adrian, who now would never exist, except maybe in the never-never world of the wormhole, and how he had caught up with him only when he went the other way. But maybe that never-never existence, like that of the children and maybe even of Cavendish, was as real as any other. "Maybe I'll tell you some time.

"Meanwhile," he continued, "I think we have managed our rite of passage and have a rendezvous with destiny."

"Whatever that means," Jessica said.

Adrian smiled at her. There would be great moments ahead, he thought, and moments of tenderness and fulfillment and maybe distress and regret and pain. But it would be living.

He heard a noise behind him and turned toward the entrance.

"Frances?" he said. "Frances?" ■

*(EDITOR'S NOTE: This story is a sequel to "The Giftie" [November 1999], "Pow'r" [January 2000], and "The Abyss" [July/August 2000].)*

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# Christmas at Ground Zero

## Linda J. Dunn

Holidays are often times for family gatherings, but this one was very different.

Jason stared out through the door's ice-covered window past the faint reflection of his age-lined face. Somewhere out there, death was coming. A meteor heading for the Midwest. Indianapolis, maybe. Chicago. Louisville. Could be anywhere unless the scientists had revised their forecast since the power went out and left him and Teresa cut off from the rest of the world.

They could be wrong. The television weatherman couldn't even guess next week's weather right half the time. How could any scientists be sure it was going to hit Earth, let alone narrow it down to their neck of the woods?

By next week, he could be shooting the breeze with Buck again, giving him a hard time about hightailing it out of here when the news hit and leaving all the livestock behind to fend for themselves.

Gary had called and tried to change their minds. Stephanie had cried. Plenty of room out there in California with them now that Marcia was married. They had meant it, too. But in the end, he and Teresa decided to stay.

They belonged here. Everything they knew was here. Starting over somewhere else would be a different kind of death.

Jason picked up his rifle and tugged on the door. The dang-blasted thing always stuck during cold weather. Teresa had gone out a bit ago, grumbling something about Christmas dinner come hell or high water or any stupid rock hurling through space. She'd been gone too long and he didn't trust the night. Their farm was off the main highway, but someone might take the back roads and think nothing about shooting an elderly couple for a can of gasoline to get them a little further along their escape path.

*Fools! For all they knew, they could be driving straight into it. Best to stay put where you are and hope it hits Detroit instead. Not that it matters. If it re-*



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*ally hits, life will never be the same again.*

"Jason?" Teresa called from the storage shed. "Can you give me a hand with this grill?"

Jason leaned his rifle against the side of the shed and flipped the light switch without thinking. No lights. It was easy to find her, though, because she was making enough noise to wake the dead.

"What are you up to in there?"

"About five-two," she said, and he could hear the laughter in her voice. "Really, Jason, you heard me inside. I'm dragging out the grill. We can barbecue the turkey for Christmas."

He wanted to laugh at the absurdity of it all, but didn't dare. If it made her feel better and gave her something to do beyond watching and waiting to see which way the rock fell, then so much the better.

He pulled the lawnmower aside and began rearranging things to reach the grill. A few moments later, a loud clap of thunder and bright light lit up the shed and then a blast of wind through the open doors knocked them both to the floor.

*Damn scientists couldn't even get the time right!*

"Jason?" Teresa's voice quivered with fear. "Was that it? I thought it wasn't due until tomorrow."

He pushed himself upright and helped Teresa to her feet. "I'm not sure—" And that's when he realized he was staring into Teresa's face and seeing her soft blue eyes and loose strands of gray hair. Light. The bare light bulb swung on its cord, casting shadows and illuminating all the tools that had scattered when they fell.

They stumbled outside to stare at their house.

Every window reflected bright light and strands of Christmas lights twinkled in rhythm from the rooftop. Music—Christmas music—blared out into the night.

And yet when he looked around, there were no lights along the road or in the distance from neighboring homes.

"What the hell—?" Jason picked up his rifle and gave Teresa's hand a tight squeeze. "Stay here. I'll find out what's going on."

"Oh, don't be a Neanderthal, Jason. I'm a better shot than you are anyway." She eased the rifle out of his hands and he let her take it. She was a better shot . . . and he didn't have his glasses on.

They walked slowly towards the living room window and peered inside. Two men and a young woman were moving around gesturing at various things and pausing to talk beside the Christmas tree. The music faded and switched into a different beat that felt oddly familiar and yet more foreign than anything they had ever experienced before. The strangers moved through their living room, studying every photo they had and rifling through Teresa's antique cherry cabinet. Their skin was dark but they didn't look Afro-American. Indian maybe. The country, not the Native Americans. No beards. Smooth skin without a trace of facial hair on the men. Not much in the way of eyebrows either. Narrow noses. Thin lips. Slanted eyes like Asians. Hard to place their nationality but they sure as hell didn't belong in Indiana-no-place.

Before Jason could stop her, Teresa opened the door and stepped inside. "Nice party," she said. "Mind if we join you? It *is* our house, you know."

The three turned toward them and the music died. They studied Teresa for a long moment and their mouths formed round O's before they turned to one another to chatter furiously in a language that didn't sound like any form of English that he'd ever heard. Not even New Yorkers talked that fast.

Jason stepped forward from the shadows, just to let them know that they couldn't try to jump Teresa. They might be outnumbered, but not by much.

The girl smiled and took a step to-



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ward them. Her almond-shaped eyes were blue and her short-cropped hair was a kinky reddish brown. She spoke slowly and with a thick accent that was most assuredly not East Coast. "Are you the owners? We thought everyone had fled."

One of the men stepped forward and he had the same blue eyes and dark skin. His blonde hair, however, was long and french-braided in a style that would look effeminate if he weren't at least six-foot-five and broader than a football player.

"We are college students," he said with the same thick accent. "We are driving to a safe zone and our transport developed motor problems."

"Kind of off the beaten path," Jason glanced at Teresa and noticed she looked every bit as worried and confused as he felt.

The other man stepped forward. Whereas the first was a linebacker, this one was a quarterback. One that spent a lot of time on the bench. He didn't look like the first two. Brown eyes and black hair. More Asian-like and yet still different. A little older, too. "The roads were crowded." His words were barely distinguishable through the thick accent. "We thought it best to travel the roads in the back."

"How did you get the electricity working?" Teresa asked.

The three exchanged a furtive glance and then the young woman said, "We found a generator in an abandoned vehicle so we took it with us."

He looked toward the boys and the linebacker added, "The vehicle was empty of fossil fuels."

Liars. No way they could pull up that fast and then have the lights on in seconds. Generators take time to set up. And their speech—what country or planet were these people from?

"I am Mary," she said, gesturing at herself and then turning to the two men. She pointed at the linebacker—the younger-looking of the two men. "This is Tom and . . ." he gestured toward the quarterback, ". . . Bob.

*With those accents? And their last names are probably Smith, Jones, and Wilson.*

Teresa slipped the safety back on and leaned the rifle against the wall before extending her hand towards them. "Hello," she said. "I'm Teresa and this is my husband, Jason. As long as you've been kind enough to give us lights and heat, why don't you bunk down in our spare bedrooms for the night and join us for Christmas tomorrow? Or are you planning to just stop long enough to get your . . . transport . . . functional again?"

Tom—the linebacker—grinned with a bit too much relief in his eyes. "Thank you. I am afraid we are stranded for the duration. We much enjoy your hospitality."

"And we enjoy your turning our lights back on," Teresa almost mimicked his accent but they seemed oblivious to her speech.

"Where did you say you folks were from?" Jason ignored Teresa's evil glance at his question but the girl answered quickly, "Louisville. We attend university there. But we are from . . ." She glanced at the men before saying, "Thailand."

Nice. He could almost believe that. Mixed pedigrees and all. But not with those names.

He opened his mouth to say something but Teresa caught him in the ribs with her elbow and glared at him. "Are you hungry?" she asked the trio. "I've got food thawing in the freezer and it's going to spoil if someone doesn't eat it."

They stared at her like she was speaking some foreign language.

"I would like something," Mary said. "And do you make your own food? Do you have . . . instructions? May I take pictures?"

"Just follow me into the kitchen," Teresa said. "I've got a box full of recipes and you're welcome to all of them. They're not going to do me much use after tomorrow."



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No one could resist a command from Teresa. They all followed her into the age-old kitchen that he'd promised to modernize someday. The pine cabinets caught their attention immediately and Tom wandered over to the chipped white sink to stare down the drain and then poke his fingers into it. He gestured to Bob and they started jabbering away again in that funny speech and pointing down the drain.

Teresa didn't notice them. She was too busy digging through the refrigerator and pulling out plastic containers. "It's been a little lonely out here since Gary left. I must say I miss preparing a big meal. It'll be nice to have company for dinner tomorrow."

Jason and Teresa argued about the visitors later—in bed—after she'd fed "Mary" a big meal for such a little girl and then persuaded the two men to sample a few things. Ice cream was the big hit of the evening. You'd think they'd never seen it before.

And that was what they argued about, once Teresa fussed the spare room clean while Jason gave them a brief, walking tour of the place.

"They're aliens, like in the movies, and that asteroid is actually their bomb." Jason's muscles ached from tending his farm and all the neighbors' as well, and yet he couldn't imagine falling asleep now.

Jason unhitched his overalls and draped them over the chair like always. He lay down beside Teresa and wrapped his arms around her. "They're probably lizard creatures who have us hypnotized to think they look like humans."

Teresa groaned and twisted around in his arms to face him. "You've seen too many movies. They're not aliens."

"No? You want to tell me they're from Thailand? With those inhuman accents and—"

"Oh, give it up, Jason," she said with a yawn. "They're not aliens. They're time travelers. Probably archeologists."

He stared at her for a moment, considering the possibility. "So all we have to do is convince them to take us with them."

Teresa's voice was groggy and far away. He hated it when she fell asleep while they were still talking. "And why should they do that? We're old and we belong here. We wouldn't have any more idea how to behave in their time than they do in ours. Less."

She yawned again and said, "Go to sleep. We'll talk about it in the morning."

As if anyone could possibly sleep while time travelers were prowling through their house. He got up after a while and sat down in the rocking chair his great-grandfather made long ago. Teresa rocked Gary to sleep so many times in this chair. Seemed like yesterday he was just a little tyke tagging along after him and now he was some big-shot executive out in California going to work in tattered clothes and raking in more money that Jason had ever dreamed of earning on the farm.

Jason stared out the window and wondered when they would see the light from the incoming meteor and how much time they'd have once they noticed it was coming. He sat there rocking until almost dawn and then, unexpectedly, he woke up to the heady aroma of bacon and eggs.

He turned on the radio and couldn't pick up a single station. Cable was still out, too. They had power—but nobody was out there broadcasting.

He found the trio in the kitchen, eating pancakes soaked in syrup and nibbling on other food like it was some sort of exotic dish that they weren't quite certain wasn't poisonous.

They didn't notice he was there and one of them palmed something into a little box that flashed green. Teresa's theory sounded right about time traveling. But they could still be aliens.

"Good morning, Jason," Bob said. "We are enjoying your bountiful harvest. It must be very interesting to grow your



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own food. Does it give you a great sense of pride?"

"More a great sense of poverty," he said carelessly. "Farming is too expensive nowadays. I rent the fields to one of the younger boys and we stopped keeping livestock long ago. Teresa's still got her garden, though, and enough canned goods to feed half the country for the next five years."

"I saw some animals on the way in," Tom said. "Cows?"

"Angus. Belong to the Hargroves down the road. I'll be feeding them a bit later since Buck's family took off along with most of the rest of the fools around here."

"Why don't you boys go with Jason this morning to feed the livestock?" Teresa suggested. "Mary can help me get the food started for our Christmas meal and when you come back, we'll open our presents and talk a little."

Jason glanced at Teresa inquisitively and she merely smiled. Ah! He got it. She wanted to get Mary alone to see if she could pull information out of the girl. Well . . . not a bad idea. "Follow me, boys," he said. "I'll give you a firsthand look at those . . . cows."

Bob and Tom fussed with everything on the short ride over to the barn. They ran their fingers over his truck's interior and asked countless questions about farming techniques and livestock. They got real upset when he explained the Hargroves' cattle weren't some kind of expensive pets but meat on the hoof and then talked about how he used to raise hogs. Only thing that made sense was that they were some kind of vegetarians or else they had squeamish stomachs. They looked pretty puckish when he explained how his granddad used to process sausage.

Jason broke up the ice in the water so the cattle could get a fresh drink. Not that it mattered—they'd all be dead before nightfall.

"Kind of a waste of time, isn't it?" he asked the men when he finished, not really expecting an answer.

"It is never a waste of time to make life comfortable," Bob said a little too quickly. "They appear far more intelligent than I had expected."

"Too smart by half, sometimes," Jason said.

The ride back was cold and quiet. Whatever the strangers felt, they didn't say anything. Jason thought about asking them then and there if they were aliens or time travelers . . . but he just couldn't bring himself to do it. He was ready to die. Had made his peace with God and everything.

But now he was getting cold feet.

Death is pretty damn final. He'd kind of hoped to live at least long enough to see the first great-grandchild. If Teresa was right, they could take them forward in time to see a many-generations-removed descendant.

*If we have any.*

The boys didn't touch the turkey, but they dug into the dressing and dumplings. The pumpkin pie was a big hit and Mary marveled over Teresa's chocolate pudding. They small-talked their way through the meal with the three asking oddly phrased questions about life in a farming community and Teresa providing most of the answers. Jason waited until they started clearing away the dishes before asking the question that was chewing at him.

"Any chance we can persuade you folks to take us with you when you high-tail it out of here?"

The three stared at one another and then said as one, "What?"

"You're not from Thailand. I figure you're aliens and Teresa thinks you're time travelers. Which one of us is right?"

"I told you 'no'." Teresa said sharply. "I'm too old to make that kind of change. I'd just as soon stay here and wait for the meteor."

Mary burst into tears and she dropped a plate on the floor that shattered into pieces. That just made her cry more and Teresa wrapped her arms around her.



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"There, there, sweetheart. It's all right."

"No, it's not all right!" Mary screamed. She turned to her two companions and said something in that odd-sounding language. Tom and Bob shook their heads. Mary stomped her foot and argued back. They folded their arms across their chests and stood firm.

Tears ran down Mary's cheeks when she turned back to them. "Teresa is right."

The men shouted in that strange language of theirs and Mary turned around to argue with them again. They went on like that for a few minutes until Teresa shouted out, "Stop that! It's Christmas and I don't want any unpleasantness here today. The good Lord knows we've got enough to face without it."

Their voices ceased and Teresa smiled. "That's better." She turned to Jason and said, "I'm staying. Do you want to go without me?"

Jason shook his head. "Good lord, woman! No. I just . . ." He stopped and looked around the room. He couldn't understand their language and from what little he'd seen thus far, they'd be lost trying to finish out their days wherever these people lived.

"I'm sorry. I guess I was grasping at straws."

She reached out for his hand and squeezed it. "I understand. I'm not much looking forward to this myself."

Teresa sighed. "Well, let's not stand around in here. There's really not much point in putting the dishes in the dishwasher anyway. I doubt anything will be left for people to find later.

"Let's sit down and we can have a nice chat about where you folks really are from and then—"

"We need to be going," Bob shuffled his feet nervously and glanced at the band on his wrist. "We were supposed to just record everything we could and return this morning, but . . . we didn't expect to find anyone remaining behind. We thought you fled with all the others and died in the aftermath."

Mary reached forward and thrust a crudely wrapped package in Teresa's hands. "Here! Nothing can come back with us except what we brought. That's why I recorded all your recipes. The rules say nothing can come back, but . . ." She stopped and turned to Bob. "I carry it with me always and it is such a small thing. It will perish when the meteor hits." She turned to Bob. "I can give it? Yes? A small Christmas offering."

He stared at her for a long moment before jerking his head in a terse nod. "Yes. It cannot possibly affect our present."

They backed away to the front door and he heard the doors of their so-called "transport" slam shut. A shrill whine and bright flash signaled their departure. The electricity continued working.

"We've only got a little time left to live," Jason said. "The world's ending. At least for us." He glanced out the window and wondered if it was his imagination or if the sky really did look a little brighter.

He turned at the sound of paper tearing in Teresa's hands. "She must have wrapped this while I was finishing up in the kitchen—after we looked through all the photo albums. Never saw anyone before so interested in strangers' pictures."

Jason slumped into his favorite chair and studied the package in Teresa's hands. "What did she give you?"

"I'm not certain," Teresa said. "It looks a little like one of those snow globes."

She set it on the television and they watched the misty globe swirl and then sharpen to reveal a holographic image of Mary and then, a few moments later, an image of another woman displayed. Over several minutes, they watched image after image cycle long, slow seconds through what appeared to be a series of family photos.

"Genealogists," Teresa said, her voice full of awe. "Not archeologists."

"What?"



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"Roots. Searching and trying to find out as much as you can about your ancestors and how they lived. It wasn't chance that bought them to our house."

"I still don't understand," Jason said.

"Watch. I expect several more photos. It's moving backwards. So many generations. So much variation. All of them Mary's ancestors." An image in the next shot looked much like Marcia—their granddaughter—but that wasn't her husband at her side and two of the children had their father's dark features.

One more blanking of the display and then the last one. The very last one. Gary and Stephanie.

Jason turned to Teresa. "I bet it upset her greatly that she couldn't take any of the photos back with her."

"Oh, I suspect she passed the recorder over them and there will be pictures of the lost ancestors showing up soon for our many-great-grandchildren to enjoy."

He reached out for her hand. "I suppose that should be some comfort, but I still don't want to die."

She squeezed his hand tightly and said, "I don't want to die either. But at least we're going together."

They held each other tightly and talked about everything except the meteor while the sky grew brighter outside their window.

They never felt the wind. ■


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# THE CARBON NANOTUBE—MIRACLE MATERIAL

Suppose you read a science fiction story in which a new material had been discovered. It was supposed to conduct electricity better than copper or silver, but it could also be made into a semiconductor for transistor fabrication. It was far stronger than steel, strong enough to support much more than its own weight as a fiber hanging down to the surface of the Earth from geosynchronous orbit, yet so compact that such a fiber long enough to reach from Earth to Moon could be rolled up and stored inside a poppy seed. The material could absorb and store vast quantities of hydrogen, thereby storing fuel for powering fuel cells and pollution-free automobile engines. It could also change its length by 10% in an electric field, forming an artificial muscle, and could be used in reverse to produce electrical energy when flexed, for example by wind or ocean waves. It could be used to emit electrons to make wall-size ultra-thin video displays. It could be used to cut or strengthen other materials. And it was made from one of the commonest of all materials, ordinary soot.

I think you will agree that a story line involving such a material would strain your suspension of disbelief to the breaking point. How could the author ask us to swallow such a ridiculous fabrication? And yet, there is an actual material that, even as you read this, is emerging from the physics laboratories of the world, and it has all of these properties. It is the carbon nanotube, a new form of carbon discovered in 1991.

* * *

The nanotube is a molecular cousin of a form of carbon that is perhaps more familiar—the $C_{60}$ molecule or buckyball, an array of 60 carbon atoms forming a soccer-ball-like icosahedron. If the buckyball could be sliced in half, with a "belt" made of a connected loop of 10 carbon atoms inserted in the cut, it would form another stable configuration, a $C_{70}$ molecule that is a larger and somewhat elongated buckyball. If instead one inserted two or three 10-carbon loops, this would make an even more elongated $C_{80}$ or $C_{90}$ molecule. The process could be repeated to produce an arbitrarily long tube, with endcaps made of half-buckyball hemispheres. The object thereby produced is a species of carbon nanotube.

Alternatively, a nanotube might be produced by starting with a planar one-atom-thick sheet of graphite. Graphite is an array of linked carbon atoms lying in a plane, with the carbons forming the vertices of linked hexagons, like the cross section of a honeycomb. In principle, a skilled nanotailor could cut a strip out of such a graphite sheet, join the cut edges to form a tube, and then cap the open tube ends with half buckyballs. Again, the result is a carbon nanotube.

However, there are several ways that the nanotailor could have cut the strip from the graphite sheet. A graphite sheet of hexagons can be oriented so that one set of hexagon sides is vertical. In this case, a horizontal cut along a row of hexagons goes alternately up and down in a zig-zag, following the hexagon edges.



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Illustration by Wolf Read

This is called a "zig-zag" cut. If the strip used to form the nanotube is made such that the open end of the rolled tube forms such a zig-zag, it is called a *zig-zag nanotube*. If the length of the strip along this edge spans, say 6 hexagons, then the resulting nanotube is identified as having the index (6,0). The first number is related to the circumference of the nanotube and the following 0 tells us it has the zig-zag configuration.

On the other hand, the graphite sheet could also have been oriented so that one set of hexagon sides was horizontal. In this case, a horizontal cut along a row of hexagons goes up, across, down, and across, following the edges. This is called an "armchair" cut because the cut line resembles a row of armchairs arranged side-by-side. If the strip used to form the nanotube is made such that the open end of the rolled tube forms such a armchair pattern, it is called an armchair nanotube. If the length of the strip along this open edge spans, say 6 ups and downs, then the resulting nanotube is identified as having the index (6,6). For all armchair nanotubes, the second index number must match the first, and is related to the circumference of the nanotube.

There are also "chiral" nanotubes that, if viewed end-on, show a clockwise or counterclockwise spiral pattern. These are intermediate between the zig-zag and armchair configurations and are characterized by the index (m,n), where $0<n<m$ for counterclockwise spirals and $0<m<n$ for clockwise spirals.

Some, but not all, nanotubes are good electrical conductors. This is because nanotubes are small enough that quantum mechanical effects dominate their electrical conductivity. In particular, the quantum wave functions of the conduction electrons are either reinforced or destroyed by the symmetries of the nanotube. For example, nanotubes with indices (6,0), (6,6), (9,0), and (9,9) are all excellent electrical conductors. On the other hand, nanotubes with indices (7,0),



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(8,0), (6,2), and (7,5) are all semiconductors, materials in which there are no free conduction electrons. If a nanotube is an electrical conductor at all, it is a very good conductor indeed, because the electrical conduction is the result of coherent participation by all the carbon atoms in the nanotube. Consequently, nanotubes have a theoretical maximum current density that is 1000 times higher than that of excellent metallic conductors like silver and copper.

We find that nanotubes produced in a strong electric current often form concentric multilayer nanotubes. For example, published electron microscope images show nanotubes with two, five, and seven concentric walls. Theoretical calculations show that it should be fairly easy to produce such concentric nanotubes with layers that are alternately insulators and conductors. Therefore, a nanotube "coaxial cable" with a conducting core and conducting jacket separated by one or more insulating layers should be possible. Such a nanotube should have interesting applications, not only for signal transmission at the nanoscale, but also for creating linear capacitors with a very high capacitance for storage of electrical energy.

The semiconductor nanotubes also have their uses. Scientists at IBM have deposited nanotubes randomly on a microchip pattern of conducting copper, then applied a large current pulse to burn away the conducting nanotubes. They have then demonstrated field-effect transistor behavior in surviving semiconductor nanotubes.

Nanotubes are among the sharpest objects in nature, leading to other interesting electrical applications. If a sharp object is placed at a high electrical potential, an extremely large electric field develops near the pointed end. If the pointed tip is made electrically negative, it will emit electrons that are accelerated in the strong field. This phenomenon is called *field emission*. Samsung Electronics has produced a prototype ultra-thin, very high resolution, flat-panel display that uses the field emission from nanotubes to fluoresce phosphor pixels placed opposite in planar geometry. This is a big step towards the "video wallpaper" that is a common techno-prop of science fiction.

The mechanical strength and low mass density of nanotubes is also impressive. They share many of the strength properties of their molecular cousin, the diamond. For example, nanotubes are expected to have a tensile strength equal to that of diamond, about 130 GPa (18,900,000 pounds per square inch). For comparison, the best steel has a tensile strength of about 5 Gpa (725,000 pounds per square inch). On the other hand, nanotubes should have about the mass density of graphite—about 1.9 times that of water or about 1/3 the density of steel.

In his novel *The Fountains of Paradise*, Arthur C. Clarke described an orbital elevator or "skyhook" that used a 22,000-mile-long cable to raise and lower payloads from the Earth's surface to geosynchronous orbit and beyond. A cable that hangs from geosynchronous orbit to Earth and has a density that is 1.9 times that of water will produce a tension on the highest part of the cable of 92 Gpa (13,300,000 pounds per square inch). This is only about 2/3 of the estimated tensile strength of nanotubes, so a uniform cylindrical cable of any diameter that is fabricated with nanotubes should be able to function as a skyhook. The 22:1 tapering techniques that would be needed with weaker materials are unnecessary with nanotubes fabrication.

To put it another way, the relevant quantity for judging construction materials for skyhook construction is the ratio of tensile strength to density. Under this criterion, carbon nanotubes should be about 80 times better than steel and about 16 times better than the best plastic materials so far considered for this purpose. Moreover, nanotubes have already shown the tendency to form themselves into bundles or "nano-ropes" that



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should be an ideal skyhook construction material.

Unfortunately, present fabrication techniques can make carbon nanotubes only a few tenths of a millimeter long. This falls far short of the lengths (a few meters) required for skyhook cable fabrication, or even the centimeter lengths required for strengthening composite materials.

It has been discovered that shining laser light of the right wavelength on a nanotube can make it vibrate in a "radial breathing mode," in which the entire nanotube alternately increases and decreases its diameter. The light wavelength that excites this vibration mode depends directly on the diameter of the nanotube. Therefore, the technique can be used to measure diameters of nanotubes and perhaps, by applying a pulse of high laser-light power, to destroy unwanted nanotubes of a selected diameter.

Vibration techniques have also been used to estimate the spring-related properties of nanotubes. Vibrations of the free end of a nanotube that is clamped at the other end are measured. This work indicates that nanotubes can make exceptionally stiff springs, with a Young's modulus that is 5 times higher than that of steel (1.0 TPa as compared to 0.2 TPa).

Under compression, nanotubes appear to be more forgiving than other materials, because they tend to fold rather than fracture. They are seen in electron microscope images to form bends and kink-like ridges under compression and torsion, and to relax elastically when the distorting forces are removed. It has been suggested that mechanical compression of nanotubes can achieve such a large mechanical energy density that stressed nanotubes should be considered as candidates for explosives as well as for mechanical energy storage devices.

Because of their tubular geometry and variable diameter, nanotubes can also be considered as pipes for transporting other atoms or as test tubes for containing them. Techniques have been developed for opening and closing nanotube ends. Nanotubes encasing silver nitrate molecules have been used to deposit nano-beads of silver. It has also been discovered that nanotube holes provide excellent high-density storage for hydrogen gas.

This brings us to the problem of how to make nanotubes. For long nanotubes, we would like to be able to pull single nanotube fibers (or even complete nanoropes) out of some hot carbon source medium. Unfortunately, the only fabrication method presently available is to vaporize carbon in an arc discharge (20 volts at 100 amps), with a small amount of iron, cobalt, or nickel added to the arc. This creates nanotubes in sub-millimeter lengths at best.

However, the nanotube fabrication technology is rapidly evolving, and there are already at least nine commercial nanotube suppliers. I predict that this is a growth industry. Watch this column for further developments. ■

**AV Columns Online**: Electronic reprints of over 100 "The Alternate View" columns by John G. Cramer, previously published in *Analog*, are available on-line at: http://www.npl.washington. edu/av.

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Historical patterns repeat on many scales. . . .

# The Great Miracle

Michael A. Burstein

It gets dark early this time of year, the time of the winter solstice, and it gets cold far too early as well. I feel that cold much more in my bones nowadays. It gets under my tunic and into my blood, no matter how many layers I wear. Perhaps it comes with old age, as inevitable as the wrinkles on my face and the aches in my joints. But despite the chill, on this particular winter solstice night I stood outside among the ancient Temple ruins to watch the setting of the Sun.

My daughter knew of my desire to stand out here on this particular night, as I've tried to do every year since we finally returned to Earth. Some years I've been too ill, and some years the harsh weather convinced me to stay inside. But I suspected that this solstice night would be my last. As the Sun finally disappeared below the horizon, I looked up at the stars, grateful to God that I had lived to enjoy this holiday season one more time.

The chill wind started to howl more fiercely, and dusty snow began pelting my face. I began to cough, so I hid my head deeper within my parka and walked back through the darkness to the shelter of my family dwelling, just a hundred meters away. The temperature started to dip far below freezing, but I did not regret my decision to come outside. After all, this night was special, and not just because of the solstice. This night was also the anniversary of our victory over the Leyens.

The door of our home slid open slowly and got stuck, so I had to push it to get it to open all the way. My son-in-law had been meaning to fix it, but other, more necessary repairs had taken precedence. I walked inside and discovered my daughter standing in our foyer, waiting for me with a slight scowl.

"*Abba*," she said, cutting past me to push the door closed. The word means "father" in our ancient holy language. Hannah only calls me that when she's annoyed.

"Yes, daughter?" I said with a smile.



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"You shouldn't go out at night. I was getting worried. We all were." She helped me remove my parka and she ushered me towards the retaining fireplace, where a small log burned and gave off a mild heat.

"I don't have many more nights left, Hannah. Let me enjoy them."

"I was afraid you wouldn't come back," she said softly. She hung my parka in the closet. "We need you tonight. For the telling of the story."

"I know, I know. I'm here, aren't I?"

She adjusted the kerchief that covered her hair. "Come. The others are waiting."

As we walked into the parlor, the smell of frying potato pancakes wafted in from the kitchen, filling my nose. My mouth watered. The smells mixed with the sounds of my seven grandchildren, shouting with glee from the circle on the floor where they played their game of spinning tops. An oil lamp bathed the room in a dull glow.

As Hannah scurried past me to the kitchen, I tiptoed around the circle and settled in my easy chair, near the parlor fireplace. Just as I fell onto the cushions, my grandchildren looked up from their game.

"Grampa's here!" little Jacob shouted, and he jumped towards me, laughing. A grandfather shouldn't play favorites, I suppose, but I've always favored the youngest. Every new grandchild reminded me that the human race would go on.

Jacob hugged me and tangled his fingers in my white beard. I picked him up and put him aside so I could grace each of my grandchildren with a hug. When I was done, the circle of children had reformed, gathered around me. Hannah came in from the kitchen, wiping her hands on a worn blue cloth. Her husband Shimon followed her in. The two of them sat in the wooden chairs near the table and smiled at me. I smiled back.

"Jacob," I said, "what night is it?"

"The first night of the Festival of Lights!" he replied.

I addressed the oldest, who was fifteen. "Shmuel, what do we do for the Festival of Lights?"

Shmuel had answered this question many times before. "We play the tops game. We eat potato pancakes and other fried foods. We light the candles. And we tell the story."

I nodded. "Do you want to hear the story?".

The children clamored for the tale, and so I began.

The story begins long ago [I said], back when I was a very young man. Almost as young as all of you. It was a bad time for the human race. Some of us had spread out among the stars, but most of us lived on Babylon, a planet many light-years from here. And no matter where we lived, none of those planets were home.

Put your hands down; I know you ask why we left Earth. And the answer should strike fear into all your hearts. It was because of the Leyens.

Many years ago, as many years before I was born as have passed since, the Leyens came to Earth and conquered our home. These pale, shriveled, large-eyed aliens came to each member of our race with a choice—either be driven into exile, or have our genes altered so we would become like them. The Leyens had no sense of morality, and no sense of individuality, and most of us rejected their misguided offer.

Some of us were weak, though, and I spit on their memory. Those who became assimilated started taking the Leyen point of view, wondering why we were so attached to this ball of dirt we called home. They were the ones, these Leyen-Human hybrids, who drove us into exile on the planet Babylon.

And so, from my grandfather's time until my own, we lived on a planet that we did not know, strangers on an unfamiliar world, where spring, summer, winter, and autumn did not mean what they had here on Earth. We scraped out a life for humanity and wept for the world we had once known.

One day, we heard news that filled us



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with both fear and joy. The Leyens were not the only aliens out there. Far from here, closer to the center of the Milky Way, the Leyens were fighting with another race, one that they had tried to assimilate but that had not grown as weak and complacent as we had.

The war had come, and with it, our opportunity.

My father, Matthew, the Governor of our planet of exile, called me to his office one morning and said, "Judah, this is our chance."

"What is?" I asked him.

He looked around the room as if checking for electronic spying devices. "At the cost of many lives, we've managed to secure six Leyen ships capable of hyperspace. I've heard that the Leyens have pulled their forces away from Earth, and even the hybrids have left. This is our chance to take our planet back."

You have to remember that I knew nothing of Earth, except what my grandparents had told me. Like my father, I shared a desire to go back, but I honestly never expected it to happen in my lifetime. So I calmly replied, "Really? Take our planet back? That's wonderful news."

My father cocked his head at me. "I'm glad you think so, Judah, because I'd like you to lead the fleet."

That stopped me cold. "Father," I said, "I'm a physics teacher. I'm not a soldier."

"None of us are soldiers," my father replied. "But you are my son. Your name will inspire our people and lead us into victory."

I had never heard my father speak that way, and I thought I saw tears begin to well up in his eyes. He wiped his face, however, so if he had been crying, he quickly stopped. "Will you do it, Judah?"

"Well," I began, "I—"

The door opened, and one of my father's aides interrupted us. "Governor Hammer," he said with a nod. "Forgive the interruption."

"What is it, David?"

David glanced at me and said, "We've just gotten a report confirming that the Leyens have temporarily abandoned Earth. It's ours now if we want it."

"Thank you, David." David left and my father turned back to me. "You see, Judah? You don't have to worry about being a soldier at all. Just lead the fleet back to Earth, and begin to recolonize home."

Father's words convinced me, and I agreed to take on the task. He put me in charge of the most important ship of all, the largest and most powerful, called the *Luminary*. We jumped into hyperspace behind the other five, to protect them on our trip to Earth.

And protect them we did. Because what we didn't know at the time was that the Leyens had set up a trap.

My grandchildren, my biggest hope for you is that you never know the terror of a battle. Shortly after the jump into hyperspace, we discovered that the Leyens had expected us. They had left one ship hidden near Babylon, just in case, and when they saw our six vessels, that one ship came in behind us for a surprise attack.

We were hit first, with a huge energy burst that knocked out our life support and lights for a moment. By the time my crew had gotten the systems working again, the Leyens were firing random bolts at our other five ships.

Over the hyperspace radio, I ordered the other five vessels to hightail it towards Earth as fast as possible. The Leyens must have overheard, because their ship turned around and sped towards us.

We came in fast and engaged the Leyens in a volley of bursts, blasts, and bolts. I can't remember the number of times we hit them or the number of times we got hit ourselves. The *Luminary* shook constantly, the lights dimmed and brightened over and over, and the control panels expelled sweet-smelling smoke. Finally, with our last dregs of energy, we managed to hit the Leyen ship dead center, and it exploded in the eerie silence that accompanies such things in hyperspace.

I felt exhausted; sweat covered my face



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and a bloody gash cut across my cheek. But my father had placed me in command, so I had to secure the *Luminary* before getting some rest. My crew reported on the damage, which mostly sounded fixable, until I got a call in from my engineer.

"Captain Hammer, we need you down here."

I remember shaking my head in amusement at being called "Captain Hammer," but after making sure that there were no other crises for me to deal with, I headed down to engineering. The Leyen hyperspace engine filled the chamber from top to bottom, about ten meters in height. The engineer, a woman about my age named Rebecca, pushed a button on the side of the engine that popped out a cube the size of my palm. She took it and handed it over to me.

"Here's the problem, Captain."

I turned the cube around in my hands. "It's the fuel pod."

"Look at it closely," Rebecca said. "It's fused. Inoperable."

I examined it; sure enough, the normal bright glow of the fuel pod had dimmed to a milky-white paleness. I passed it back to her. "Why did it fuse? We didn't run the ship that hard."

Rebecca nodded. "That last energy burst, the one that didn't shake the ship—it must be some new sort of weapon. My guess is that it targeted the engine chamber and sapped the fuel pod."

"Well, put in a replacement."

She shook her head and pushed a button to open up the replacement drawer. "Can't."

Now, children, this is the part that you must understand. The *Luminary* was different from the other ships. The other ships could run for months on a standard fuel pod, but the *Luminary* used that much power in a day. Since we knew it would take eight days to get to Earth, we had brought eight extra fuel pods with us in the drawer.

Only now, what Rebecca showed me was a drawer with only one working fuel pod. The other seven were as fused as the one from the engine, beyond repair.

"Powerful weapon," I said.

"Yes."

"So what do we do now?"

Rebecca looked at me as if I were a fool. Come to think of it, maybe I was. "What do we do now?" she parroted. "That's what I'm asking *you*. You're the captain."

I nodded and stared off into the distance, while trying to think of an idea. "Can we borrow a fuel pod from one of the other ships?"

Rebecca shook her head. "You ordered them forward, and they've already gone far ahead. They're out of hyperspace radio range."

"Maybe they'll come back for us."

"Unless they assume we've been destroyed."

I thought some more. "Well, we have one working fuel pod. Let's use it to go back to Babylon and get more."

Rebecca rolled her eyes. "There are no more, Captain. We took all the fuel pods we had. There was no reason to leave any behind."

"So," I said. "We'll just go home, then. We'll let the other five ships retake the Earth."

Rebecca looked around the chamber for a moment, and then, staring at her feet, she said, "With all due respect, sir, that's not a good plan."

"Why not?"

"Because the trap implies that the Leyens know we're coming. If our intelligence is wrong and more Leyens are waiting for us near Earth, our other five ships won't stand a chance against them. They need us."

I sighed. "Rebecca, you're telling me that whatever we do, we've lost."

"I'm afraid so, sir," she said. "Unless we can get one fuel pod to do the work of eight."

Children, the way Rebecca said that triggered something in my mind. I opened up the engine's fuel compart-



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ment and studied the way the wires connected from the fuel pod into the rest of the engine. I had never seen a Leyen power converter before, but it looked similar to power converters we used on Babylon. I studied the electronics intently and came up with an idea.

"Rebecca," I said, "what if we hook up the wires so it doesn't drain the fuel pod as quickly as usual? What if we adjust the rate at which power is drawn? Flip the wires around so the exhaust fuel goes back into the pod and keeps it powered?"

She bit her lip. "We'd have to skirt very close to the laws of thermodynamics. But if we did as you suggest—" She punched a few buttons on a nearby computer panel, checked the result, and smiled. "We'd have enough power from the one fuel pod to last us all eight days, plus a little more besides."

And that's what we did. We arrived at Earth shortly after our other five ships, and just in time to set up a defensive perimeter around the planet. When the Leyens and the hybrids came back, in their weakened condition we managed to take them out ship by ship. Eventually they realized that it wasn't worth it, and they left us behind to rebuild our lives the way we wanted.

But my story, as always, ends with a warning. We may have been back home for decades now, but even today, we must still watch out for the Leyens. Their empire might be crumbling, but we know they are still out there, and they would assimilate us again if they had a chance.

My story was done except for one final part of the ritual. All of the other children turned to look at little Jacob, the only one young enough to not remember the punch line.

"Grampa, that was the story of the Great Miracle, right?"

"Yes," I replied, smiling.

"So what was the Great Miracle?"

"What was the Great Miracle?" I laughed. "Isn't it miracle enough that we won our planet back?"

"Seriously, Grampa, what was it?"

Still smiling, I sighed. "The Great Miracle was that I was wrong."

"What do you mean, you were wrong?" Jacob asked.

"The technique I came up with for getting more power out of the fuel pod—it couldn't have worked. After the battle had been won, we checked the power converter and discovered that it was the wrong kind. It wasn't able to drain the power off slowly; what I had thought was a sliding power scale actually only had two settings, on and off. The physics just wasn't there. It shouldn't have worked."

Jacob looked confused. "But it did work, Grampa."

I smiled. "Ah, yes, it did. And that is why we call it the Great Miracle. Come, let us light the candles."

My children followed me over to the mantelpiece, where Hannah had already set up the candelabrum. We lit the eight candles using the flame of a ninth, and recited those ancient words, "*Nes Gadol Hayah Po*—A Great Miracle Happened Here." Then my daughter called everyone else over to the table to eat the potato pancakes, while I went to my room for a rest.

As I changed into pajamas, I gazed for a long time at the photo of Rebecca, the engineer I had met on the *Luminary* so long ago. I hoped she would be proud of the way I told the story to our grandchildren.

I was just settling into bed when I heard a knock at my door, and little Jacob came in. "Grampa, is that a true story? How can one fuel pod last as long as eight?"

He jumped onto the bed, sitting next to me. I tousled his hair, making sure not to knock off his skullcap, and sighed happily.

"Grandson, I don't know what to believe. But I do believe my senses. Look around you. We're here, back on Earth, and we have a second chance to make things go right." ■



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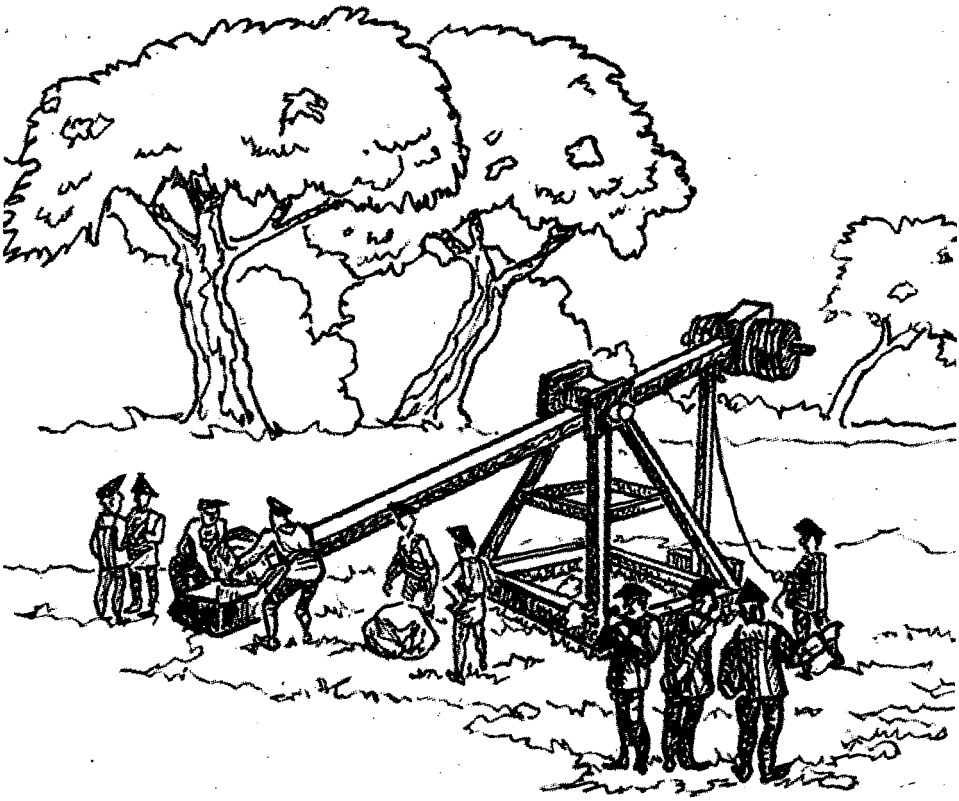
Some of the most intriguing stories in history don't show up in the official record. . . .

# Tower of Wings



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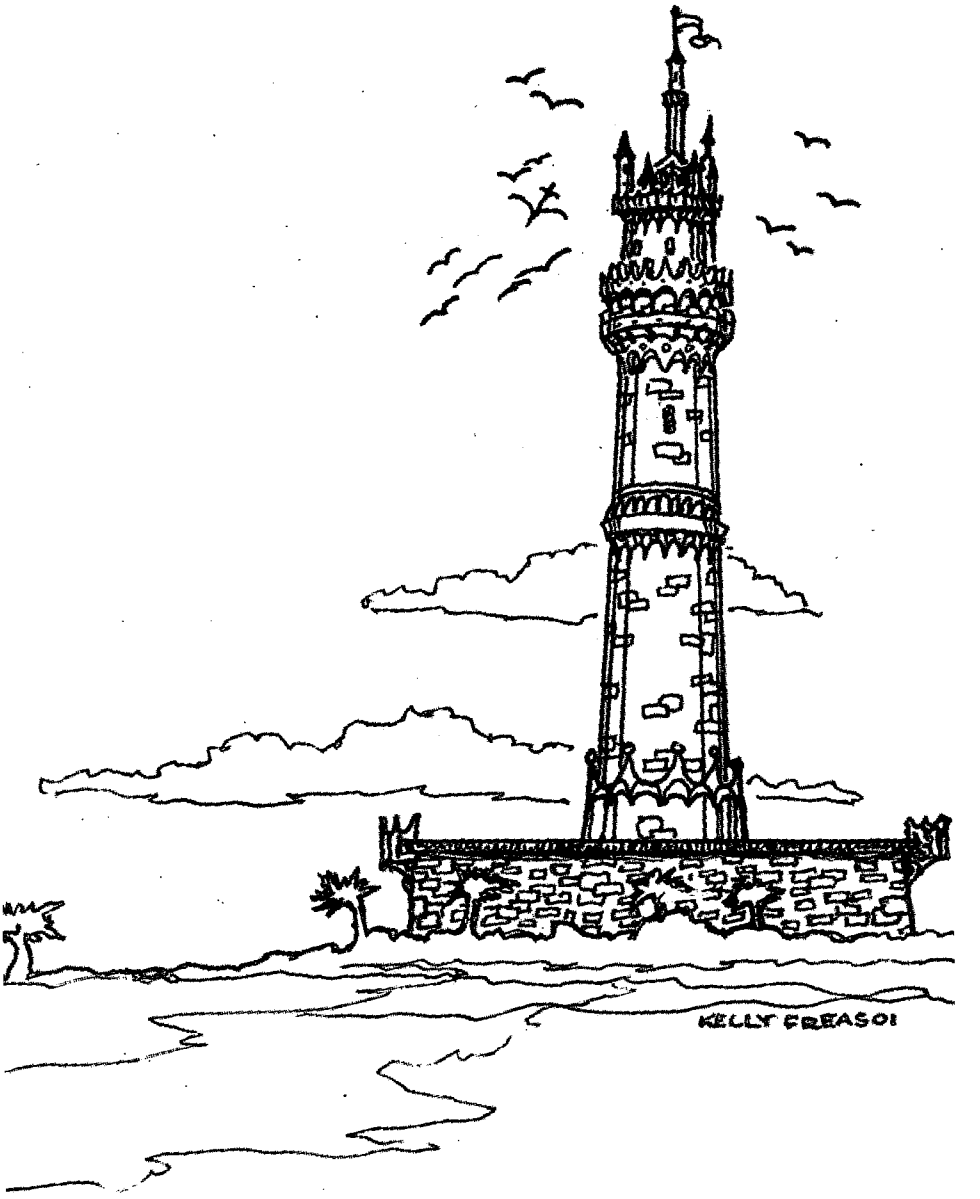


# Sean McMullen

Illustration by Kelly Freas

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Baron Raimond arrived at the Tower of Wings with his army on the morning of the last day of June in 1303. The summer solstice was not long past, and the weather was clear, warm and windless. The village near the tower was subdued and occupied so very quickly that there were no casualties on either side, but a runner reached the tower long before Raimond's men had any chance of mounting a surprise attack. Lady Angela herself stood listening as the exhausted peasant gasped out his warning for a second time.

"English, strong force, dozens, dozens, dozens," he panted as he lay against a stack of barrels. "English, under Raimond."

Lady Angela wore a fur-trimmed mantle over a kirtle and girdle, with an open veil over her parted, plaited and rolled black hair, and there could not have been a greater contrast than with the armoured fighting men milling around her, yet she was their leader.

"I ordered the drawbridge raised and all archers to the walls as soon as he came through the gate," reported the seneschal. "From the bailey wall, you can see them. The tower is surrounded. I estimate three-thousand English, and they are already clearing ground for a camp about three-hundred yards to the south."

They climbed the steps to the bailey wall, and looked out over the fields to where the English were at work clearing bushes and erecting tents.

"The Sun will be behind them for much of the day," commented Lady Angela, "and they are well outside the effective range of our archers."

"Indeed, my lady, the baron is a brave and clever warrior."

"And he can read and write. He read all of my books as we nursed him back to health here two summers ago."

"Now see how he repays your kindness."

"I expected nothing else. It is the way of the world."

The seneschal never ceased to be amazed by Lady Angela's grasp of matters that other women paid no heed. She spoke eleven languages, had ruled the Tower of Wings and its estates since she was nineteen, and had led her people through two sieges. She had also written four books, on mathematics, medicinal plants, the principles of levers, and the way that birds fly. At the top of the Tower of Wings she had a pigeon coop, and she spent many hours sitting at the windows watching her birds soar and circle about the tower and sketching them on slate and parchment. Sometimes, however, the birds that circled the tower were devices of red silk and slivers of wicker. There had been mutterings of witchcraft by peasants, churchmen and nobles alike.

"The baron read your book on wings and flight as he lay regaining his strength," the seneschal pointed out. "He must have denounced you to the English king as a witch, using your work as an excuse to mount this attack."

"If not he, then someone else," replied Lady Angela.

Baron Raimond and his master engineer Wat paced a stretch of hard, flat ground some two-hundred yards from the curtain wall of the Tower of Wings. Two of his knights stood watch as they walked, but no arrows were fired from the fortress.

"A good surface for your great machine, lordship, and an ideal distance from the walls," declared Wat, the engineer. "Just beyond the range of their archers, yet just within the useful limit of a trebuchet."

Raimond gazed at the tower, his arms folded and his expression grim. There was a moat encircling the curtain wall, and at the very centre was a single, slender, elegant tower that was said to be the tallest in Scotland, England or Wales. In the summer of 1301, he had spent two months there after being found



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wounded and fevered in the nearby forest. Lady Angela had been twenty-eight years of age then. She had treated him with oils and philters of her own devising, some brewed from herbs and plants collected in the fields nearby, and others brought from as far distant as the Holy Land, Africa, and even legendary Cathay. They had cooled his fever, drawn the angry scarlet blush from his wounds, and restored his strength.

"What say you, lordship—is she indeed a witch?" asked Wat.

"The bishops say as much," replied the baron. "She builds fearful machines and studies forbidden arts."

"The machine that we are about to build is fearful," replied Wat, rubbing his neck. "In a single afternoon it can bring down castle walls that took a dozen years to build."

"Ah, but my siege machine will do the work of Edward Longshanks. He is a Christian monarch with the blessing of the church, and the church is not anxious to offend Edward. Thus I cannot possibly be in league with Satan by building such a machine."

Wat opened his mouth to reply, yet his mind still wrestled with the convolutions of Raimond's words. He closed his mouth again, frowning with concentration, and finally scratched his head. Raimond laughed.

"It is a way with words and facts called logic. The Moors learned it from the writings of the ancient Greeks, and I learned it from Alren."

"The Moor friend of yours? He'll bring you no good, lordship."

"He just might bring me the Tower of Wings, that I may give it over to my king. Alren is within the tower now."

"Spying on Lady Angela, lordship?"

"One might say that. Order the peasants to clear this ground and commence felling timber in the forest."

At the top of the Tower of Wings, Lady Angela stood beside her pigeon coop, her wheat-filled hand smothered in hungry, flapping, jostling birds. Nearby, her Moorish guest leaned on the southern battlements and gazed across at a second encampment that was being built by the English invaders. Guards had been posted to patrol the perimeter, tents were up, latrine pits were being dug, and carpenters were building hoardings to guard against the best of Lady Angela's archers. The thud of axes echoed faintly to them, followed by the sound of trees falling.

"The English are felling oak trees," said Alren.

"I have been counting the number of axe blows for each tree," replied Lady Angela. "They are very big trees. Not the sort that one cuts for firewood."

"Ah, well observed, excellent lady. What are we to conclude from this?"

"They are building a siege engine. Baron Raimond is an expert on siege engines, and he means to take this tower."

"Ah, admirable. Just as I would deduce. The conventional wisdom would be to have your men issue forth and destroy the device when it is near completion."

"I have five knights, nine-dozen archers, twice as many men at arms, and five-hundred peasants with pikes. My estimate is that the baron has three-thousand veterans and as many peasants and artisans again to support them. We cannot do anything against odds like that. We must let the walls fight for us."

"The walls are but frail allies, excellent lady. A well-fashioned trebuchet could have them breached within a day."

"I could design a trebuchet that would fling stone back at theirs," said Lady Angela listlessly. "We have stores of timber within the walls."

"Ah, then you shall do so?"

"No. Nearly all of our carpenters were living in the village while the bridge across the river was being rebuilt. We only have two carpenters in here. Baron Raimond has perhaps sixty, from what I can see. His engine will be ready to fling



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stone within a week or so. I could not hope to have one finished within a month."

"Sad but true, my excellent lady. What will happen when the walls come down?"

"King Edward wants this tower taken, Baron Raimond wants the king's favour, and many in the church want me burned as a witch. When the first stone ball smashes into the curtain wall, my seneschal will surrender the tower and beg clemency from Baron Raimond for all of you."

"Us, most excellent lady? But what of yourself?"

"I shall join my birds."

Baron Raimond walked the length of the ground that his peasants were clearing, placing marker stakes at measured intervals. Wat walked beside him, watching and assessing. The rectangular oak base of the great trebuchet was already complete, and the carpenters were attaching four wheels, each half the height of a man.

"As these markers are placed, lordship, you will miss the outer wall of the tower by twenty yards," Wat pointed out.

"Good, and we shall use that cart as a target," said the baron, pointing to an abandoned ox cart near the moat.

He folded his arms behind his back and stared at the Tower of Wings.

"'Twould be a pity to damage such a beautiful tower," said Wat, following his gaze.

"Yet the tower must be taken."

"It's said you once courted Lady Angela," ventured Wat. "Did you not journey to France and win a tournament in her name?"

"I won three tournaments in her name."

"Oh, bravely done, lordship!"

"She did not even reply to my letters," sighed Raimond, shaking his head.

"But most ladies are greatly impressed by deeds of arms, lordship."

"Not Lady Angela. Her neglect, her coldness rendered me ill and angry."

"Perchance she neglects all men thus."

"No, this lady is impressed only by scholarship. When traveling through Oxford in 1292, she met an elderly friar, a great scholar named Roger Bacon. He moved her far more than the bravest, most chivalrous knight could have. He filled her head with dreams of what he called 'engines for flying', and also with disrespect for authority in general and the Church in particular. Alas, I can read and write, but I am no scholar and I cannot even compete with an old friar who is a decade dead. Thus here I am with a siege engine, determined to secure her attention by other means."

Corf and Guy inspected the twelve sandstone blocks that had been placed in neat rows before their tents. Each weighed about four-hundred pounds.

"Fine, hard stone," said Guy.

"Nothing but the best for the baron," agreed Corf.

"Stone te punch a hole through the most mighty of castle walls."

"Castles is on the way out. Soon there'll be none."

"Then how's te keep the peace?" asked Guy, scratching his head.

"Standin' armies. Castle walls makes a prince lazy. Walls need no bread or shelter. Make a wall with men, though, and he must keep grain in barns an' gold in coffers. That means wise rule an' hard work."

"Baron Raimond has a castle."

"Aye, but he don't *need* a castle."

They both looked across at the Tower of Wings, which stood tall and slender above the summer-green fields. Pigeons lazily circled the summit, and smoke from kitchen fires rose from behind the walls that encircled its base. A hundred feet away, the baron squatted down, lifted a quarterstaff weighted with stone blocks, stood up, raised the weight above his head, then squatted and set it



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down again. After thirty repetitions he paused to rest, and Wat handed him a drinking horn.

"What's bein' done?" whispered Corf.

"He means te be stronger," replied Guy.

"Surely his muscles be big enough as is?"

"Seems not."

"Aye. A brave man, he be."

"Well, time te get workin'."

They sat before a sandstone block each and began to chisel. By the time Wat came past to inspect their progress, two stone balls of three hundred pounds sat amid chips and rubble, and the masons were hard at work on the next two blocks.

Three days after Raimond arrived, a long team of oxen approached, drawing a long pine trunk lashed to five carts. Wat inspected the trunk carefully. It was two feet in diameter, quite straight and virtually without flaw. Having accepted it, Wat had four support frames built beneath the beam and the carts removed. Twenty carpenters, each with an adze, stripped away the bark, then began to chop through the pale, moist wood. By evening the trunk had been fashioned into an octagonal beam.

Wat took a knotted cord and charcoal, measured two points near the base, then called over a master carpenter.

"Bring an auger, pierce here and here," said Wat. "By morning I want the axles for the frame and counterweight to be fitted."

"We's te work in torchlight?" asked the carpenter. "Why's the hurry, m'lord? Working by daylight we'll be done on the morrow."

"Without a doubt the lady within the Tower of Wings will be building her own trebuchet. We must finish first."

"A woman can build but a poor device, m'lord. She has no skill, no experience, no art."

"The woman who commands the Tower of Wings is also mistress of mechanics, mathematics, and flight through air. Should she complete a device such as this, she could most certainly cast stones with such refinement that our own engine would be smashed to splinters, along with not a few carpenters such as ourselves."

By morning the holes had been bored and reamed out, just as the heavy wooden axles came off the treadle lathes. Under clear blue skies the peasants finished digging a saw pit, and soon the oak beams were being shaped from the raw logs by teams of peasants and carpenters working in shifts, while carpenters shaped the wooden pins, handles, axles and struts.

Lady Angela knelt on the floor of her chamber at the top of the tower, carefully placing an acorn in a silk sling. Working a tiny ratchet, she wound down the throwing arm of a trebuchet just twenty inches high. Alren stood watching from the other side of the room. He was dressed as an English noble in a tabard surcote, but with Moorish headwear.

"The secret of a good trebuchet is that it should be adjustable," Lady Angela explained without looking up. "It must be on wheels, so that the rough alignment is easy to change and casting leverage is optimised. Fine adjustment can be made by pushing the shot race a little to either side. The real elegance of the design is in the counterweight box, however."

"It is identical to the engine that is being erected two hundred yards beyond the tower walls," observed the Moor.

"The counterweight swings on the short end of the catapult arm, which is raised up as the arm is wound down. The weight of the stones in the box are the muscle that drives that mighty arm and flings the stone shot. The descending weight drags the machine forward a little, too, adding power to the cast. Add a few stones and it fires further. Take some away and it fires shorter. Nothing could be simpler. It is a marvel of good design, just like my beautiful pigeons."



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"Excellent lady, this marvel of good design is being raised to smash down your tower. Surely that must make it as ugly as a demon's frown."

"How so? Is a hawk ugly because it kills pigeons? Is a cat ugly because it kills mice?"

"Your words are full with embroidery, excellent lady, but need I remind you that the Tower of Wings is now in the position of a mouse or pigeon?"

"Life is short, dangerous and ugly, Alren, and then we die."

"Yes, and generally in pain."

"Indeed. I could die with my throat slashed open by a peasant's knife, or I could die as a stone ball from Raimond's trebuchet smashes into the Tower of Wings."

"More likely it will smash a hole in the curtain wall, his men will swarm in, and you will be captured."

"And burned as a witch."

"Excellent lady, you fashion things of silk and wicker that fly like birds, yet are not alive. It is considered that a noblewoman of your standing ought to be at embroidery or the harp, not ruling a fortified tower and commanding a thousand fighting men, and certainly not mocking the flight of angels."

Lady Angela shrugged, but did not look up from her model. "My impiety is well known. What opinion do you harbour, Alren? What should I should do?"

"Excellent Lady, I am a Moor. It is not my place to venture such an opinion."

"But it is *my* place to ask. This is my tower and you are my guest."

"I . . . wish that you should meet a man who is . . . worthy of you. Your peer, perhaps even your better. A soul mate who understands you, some lord who would charm you rather than rule you."

"Does such a man exist, wise and impartial Moorish scholar?"

"Each day I pray for Allah to make it so, excellent lady."

She looked up at last, gesturing to a window. Alren walked across and looked out.

"Look down on the bailey wall's battlements. You should see an archer sitting at rest, eating bread and cheese. Beside him is a bowl of soup."

Alren looked down, then glanced back in time to see Lady Angela pull on the model's release cord. The counterweight box full of stones and sand dropped, hauling the throwing arm down. The sling arced around and slipped open, flinging the acorn past Alren's nose and through the window. A moment later it splashed into the archer's soup. The man cried out, then cursed. He glanced about, looking for whoever nearby was snickering. Seeing nothing suspicious, he removed his helmet and scratched his head.

"That was quite masterful accuracy," said Alren, genuinely awestruck.

"It was mathematical accuracy," replied Angela.

She stood, went to a large chest and opened it. She drew out a bundle of green silk cloth and cords.

"Alren, last year, on your second visit to this tower you told me a story. One hundred and forty one years ago, in Constantinople, a Turk fashioned white sail-wings with many pleats and foldings, and stiffened by willow wands. Wearing these sail-wings, he leaped from a very high tower."

"Excellent lady, he also plunged straight to the base of the tower, broke many bones and died in agony. My great-grandfather was there."

"And his description of the sail-wings was passed down to you, who passed it to me. I have considered the matter, and have refined the design. A human body may now fall in safety from a great height with a device such as this model."

She held up a triangle of grass-green silk about half a yard on a side with strings attached to each corner. A tiny harness of leather hung from the strings, but one string was shorter than the other two.



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"It looks like a little cape," said Alren. "What is it?"

"It has no name, but by its use one may leap from a great height yet plunge through the air in safety. Perhaps I shall call it a plunge cape."

Now she lifted a mouse from its box and held it up to her face.

"Hullo, Archimedes, do you realise that barbarians are about to break into our home?" she said to the tiny, whiskered face. "You know what happened to the first Archimedes, do you not?"

"A Roman soldier killed him as he sat contemplating geometry," said Alren on behalf of the mouse.

"We cannot have you sharing his fate, Archimedes, but never fear. The plunge cape will carry you to safety."

She went to the window and sat on the sill. Deftly she strapped the mouse into the little harness.

"Come now, and watch," she said to Alren. "The harness is designed so that Archimedes is held only while his weight is unsupported. On the ground, he can struggle clear in a trice."

Lady Angela released the mouse and its plunge cape. It dropped sharply at first, then flew outwards in a long, shallow curve, about as fast as a pigeon soaring. The Moor cried out with surprise.

"A mouse, flying!"

"Given enough silk, pigs could fly as well," Lady Angela laughed.

Archimedes floated over the bailey wall, then the curtain wall and moat. Several men shouted and pointed, but no archer shot at the aeronaut mouse. All archers in the Tower of Wings were forbidden to shoot at anything that could fly. In the fields just beyond the moat, the silken triangle collapsed into the grass.

"Goodbye, little friend," said Angela sadly. "At least one of us shall survive the siege."

"That was quite wonderous," began Alren.

"But not witchcraft. I have nearly finished a much bigger plunge cape."

Alren went to the chest and looked down into it, his hands on his hips. It was filled with green silk and fine cords.

"Do you mean to escape like the mouse?"

"On the day that the walls are breached, I intend to strap on my plunge cape and attempt to fly."

"Excellent lady, you may be killed!" Alren exclaimed. "A mouse flying is all very well, but your weight is more than a thousand times greater."

"Men have flown before. Nearly three hundred years ago the Benedictine monk Elmer of Malmsbury leaped from a church tower wearing wings and flew six hundred feet."

"And broke both of his legs!"

"But lived. Four hundred and fifty years ago, the Moor Armen Firman of Cordoba flew, too. His canvas wings took him in a great circle, so that he came down safely at the base of the tower from which he leaped. His countryman Ibn Firnas performed a similar feat two decades later."

"And crashed. Excellent lady, we have no detailed description of their wings, or those of Elmer of Malmsbury."

"But I *may* fly. God will be my judge, and I shall be innocent of both witchcraft *and* suicide."

"But to what end? The mouse can hide in the grass, but you would have to fly many miles to escape Raimond's men. Can you do any better than the mouse?"

"No, I shall probably land in the moat. When I am seized by Raimond's men I shall be covered with green slime and smelly mud."

"It will achieve nothing!

"Oh, no, I might become the first woman to fly."

Alren waved his hand dismissively. "Not so. Witches fly, through forbidden arts."

Lady Angela sneered. "Because you are a Moor and beyond the trust of Christian magistrates, I suppose I can



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confide in you. I have disguised myself and kept company with witches on occasion. They make a paste of aconite, belladonna, and hemlock, then rub it between their thighs, upon their most intimate parts. I followed them as they ran through fields with brush brooms between their legs, all in a delirium from the poisons and shrieking that they were in flight, but I saw that they were merely deluded."

"Your scepticism shines in the darkness as bright as the morning star, excellent lady. Why do you then place so much faith in your plunge cape?"

"So that I might become the first woman to fly before I am burned as a witch, and that is surely an achievement. If my plunge cape fails when I jump from the tower, I shall die anyway. What would be your choice?"

"Were I a beautiful, clever and wily Christian woman, I . . . I would throw myself on the mercy of Baron Raimond, and the bishops of your Christian Church."

"Which is no less dangerous than throwing myself from the tower wearing my plunge cape. Learned Moor, when I die, I shall die attempting flight or I shall die having flown. My name is Angela: who ever heard of an angel without wings and what are wings if not to fly with? In secret, in the depths of my heart, I am grateful to Baron Raimond. He has forced me to put my life behind my postulations and theories."

By the end of the first week of the siege, the peasants of the surrounding countryside had realised that the invaders were disciplined and well behaved, and were intent only on taking the Tower of Wings. They returned to their work, some men shearing or rooing the sheep in the shade of the trees, while their wives and daughters rolled and stored the fleeces. Others cut hay in the fields, hastening to have it mown down before the sap had left it, while some beat and combed flax into long, silky strands. Raimond's men watched for any signs of rebellion, particularly among those wielding the scythes, but otherwise left them alone. The skies continued to be clear, and the weather warm.

On the seventh day of the siege, the mighty trestles to support the throwing arm's axle were hauled erect onto the wheeled base of the rapidly forming siege engine and pinned in place. Using scaffolding, ropes and pulleys, the throwing arm and its axle were raised to the top of the trestles in the afternoon of the same day. The light of the following dawn saw carpenters securing the clamps and bands that would hold the axle firm. By then Baron Raimond had a very important guest, but a guest who was in disguise and meant to be elsewhere.

"The engine now has much of the shape of a weapon," observed Edward Longshanks as he and Raimond circled it.

"All the other parts are complete, including yonder counterweight box," replied the baron. "By the end of this day, its assembly will be at an end."

"Does this mean that I may see a stone cast should I stay a day longer?"

"Sire, should you stay a day longer you will see the tower surrender, undamaged."

The king beamed with delight, then frowned. "Undamaged?" he asked suspiciously.

"Observe that long, inclined ramp behind the trebuchet. That is for my new and clever missile."

"Ah yes, a huge and fearsome missile that your Moorish friend Alren has built for you."

"You know of it, sire?"

"You have often sent Alren to spy within the Tower of Wings, and I have often sent my own spies to observe your own works and loyalty."

"I trust they spoke well of me, sire."

"In truth, they did not understand much of what they saw but they were



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satisfied that you are loyal. I shall wait for another day. Where is your Moor's wondrous missile?"

"Behind the ramp, beneath tentcloth, sire. Does our agreement still hold firm?"

"When the Tower of Wings is delivered into my hands, you may do as you will with the strange, haughty, and irreverent Lady Angela. As for Alren, however . . . I am uneasy with trusting the work of a Moor."

"We have great need of his skills, experience, and mathematical learning, sire. Does the faith within his heart really matter if the castles of Scotland are laid open to you?"

"I suppose not."

From a window in the tower Lady Angela saw newcomers arrive. There were at least two dozen riders and six pack horses. They appeared to be neither Scots nor allies of Raimond. Presently the seneschal arrived, panting from his long dash up the steps of the tower.

"Sir Philip of Nottingham has arrived to fight in your name, my lady," he announced.

"Fight? Two dozen against three thousand?"

"Fight, as in trial by combat. Sir Phillip challenges on your behalf, and Baron Raimond has accepted the challenge. A messenger from the baron asks if they may have a truce to fight before the tower."

"Tell Raimond's messenger that my answer will arrive presently, then send him back."

Baron Raimond had no sooner spoken to the messenger than Wat cried out and pointed to the tower. A large bird, with wings the span of an eagle's, had left the top of the tower and was flying in their direction. They all watched as it approached, slowly descending in the calm, warm air. It was bright green, and he soon realised that it was little more than a stick between wings.

"Bring it down!" barked Raimond to the archers nearby, and half a dozen arrows shot skyward. Two struck the silk and wicker bird and it tumbled to the ground, landing only feet from Baron Raimond and Sir Philip. It was just a pole between two silk and wicker wings, with a fan of feathers tied to one end.

"That thing flew further than an archer can shoot," whispered the disguised king to Sir Philip as they watched the baron stride over to the device.

"It has the look of a broomstick with wings," observed the somewhat unsettled Philip.

"Do witches fly on broomsticks, then?" asked the king.

The baron examined the broken model, then stood up and held a scrap of parchment high for Philip and Edward to see.

"It seems we are welcome to fight within Lady Angela's view," called Raimond.

"Do you truly believe her innocent after seeing *that?*" Edward asked Philip.

"Oh, no, but I truly believe her to deserve mercy," replied Sir Philip firmly. "My victory in trial by combat will show that God's will is that she should be spared and put into my custody."

"To become your bride?"

"Each day, each hour, I pray as much."

Work on the trebuchet went ahead without interruption while preparations for the trial by combat were made. Baron Raimond and Sir Philip confessed themselves to a priest, heard mass, and began to get into their armour. This consisted of a full suit of mail over a heavily padded aketon, an iron pot helm, and one of the new breastplates that were becoming increasingly common. All of this was covered by a brightly coloured surcoat. At either end of a measured stretch of level ground they mounted their warhorses, and were handed their shields and lances.

"Most worthy lordship, I must again advise against the use of this strange,



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heavy African wood," said Wat quietly as he stood waiting with Raimond's lance. "It weighs too heavily, yet may shatter more readily than English timbers for all of that."

"I shall be the judge of my own weapons," replied Raimond from within the confines of his helm.

To Wat's trained eye the weight of the lance in Raimond's hand stood out like a bright pennant on a battlefield, and the eyes of those watching from Sir Philip's party were no less well trained. Wat watched them conferring, probably speculating about the nature of the weight of his master's lance and the way it might be deflected. At last both combatants were ready. Both glanced to the windows of the tower as the trumpets sounded a fanfare.

Lady Angela gazed down at the distant spectacle, carefully stitching red silk over a piece of wicker the length of a quarterstaff. Beside her, a maidservant was forcing a heavy needle through the leather straps of a harness, under instruction from Alren.

"To support my weight in the most ideal of modes, two additional straps should go between my legs," said Angela without looking away from the distant combatants.

"My lady, that would be most gross and unseemly," protested the woman, shocked at the mere suggestion.

"I could wear trousers, such as men do."

"You would be condemned as a wanton."

"Is this worse than being condemned as a witch?"

The woman frowned down at her work.

"Excellent lady, I feel as if we are preparing your funeral shroud," said Alren.

"You have little faith in my former suitor, Sir Philip. He has a strong sword arm."

"He would have made a fine and valiant husband. Why did you spurn his advances?"

"Have you ever met him?"

"No, but—" he began, but Angela held a finger to her lips.

"Hush! Raimond's trumpets announce my fate."

Both riders leveled their lances, hunched behind their shields and urged their mounts into motion. Cheers and the drumming of hooves reached the Tower of Wings, Lady Angela stopped sewing and held her breath. The stallions closed; there was a sharp, splintering crash. Fragments and fittings flew through the air as Sir Philip was knocked from his saddle. He fell heavily to the ground, rolled and tumbled, but then got to his feet. A great cheer went up from the baron's men. As the baron came around in a circle, Philip tried to draw his sword. The baron dropped his broken lance and dismounted. He stood ready, sword and shield raised. Philip tried to draw his sword again, but was unable to. Now Lady Angela realised that Philip's sword arm had been broken in the fall.

It was quickly obvious that Sir Philip could fight no more that day. He was put on a litter and carried away to the tents of Baron Raimond's camp. Raimond walked across to speak with his marshal.

"Raimond is victorious," said Angela as she returned to her sewing.

"Such a brave and valiant effort," said the maidservant, tears streaming from her eyes.

"Were one tenth of the effort put into jousting to be put instead into the study of birds and wings, why, within a hundred years we would be flying in preference to riding horses."

"My lady, how can you say such a thing? Sir Philip risked his life to save yours."

"Sir Philip risked *his* life? For *me?* Merciful God, does nobody ever stop to ask what *I* want? Whether *I* would like to risk *my* life?"

"You already risk your life, my lady,



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studying dark and disturbing arts as you do."

"Enough!" barked Angela, standing and pointing to the door. "Get out!"

When the maidservant had gone, Alren picked up the harness and began forcing the needle through the leather.

"She was right, excellent lady," he said as he worked. "You risk being tied to a stake and set afire."

"There are other risks, exhilarating risks. Imagine this: imagine fifty spirited horses in a single team, thundering down a long, straight beach at low tide. They are pulling a cart and on that cart is a flight engine, not merely a yard from wingtip to wingtip, but *fifteen* yards. Upon the back of the giant flight engine is strapped my very self."

"A grand scheme, most excellent lady," said Alren, looking up but seemingly not surprised.

"As the speed increases, the flight engine rises high into the air. I work a lever and drop the tether rope, I fly free, working the attitude of the wingtips with cords attached to my feet. I soar out over the water, I fly back over the land. I fly in circles, then I come gently down to the wet sand, sliding to a stop on a skid of springy wickerwork."

"Armen Firman has already proved that such flight is possible, excellent lady."

"Indeed, but inefficiently, with mere wings. Fifty years ago a colleague of the great Friar Bacon postulated a flight *chariot*, with flapping wings. He even built one, and tested it from a high cliff."

"Did it fly?"

"Straight down."

Alren said "Ah," then looked back to his sewing.

"I have studied all aspects of flight, Alren. Humans *can* fly and live to tell of it, Armen Firman and Elmer of Malmesbury proved that. Humans are too weak to flap wings as birds do, however; Friar Bacon's friend died proving that fifty years ago."

"So did al-Djawhari of Nisabur, three hundred years ago."

"Yet birds may soar by merely holding their wings in a shallow v-shape, and my silk and wicker models fly equally well," insisted Angela, blazing with enthusiasm. "Models prove that machines can fly. Friar Bacon's colleague was almost right. A flight chariot can be built to soar like a bird with its wings held in a v-shape, something that can *carry* a human. Just consider, a man cannot ride a goat because he is too heavy—"

"But a man can ride in a cart pulled by a goat," said Alren, closing his eyes and wearily putting a hand to his forehead. "A man cannot wear wings big enough to support his weight, but he can fly within a flight *engine*, that has sufficiently big wings."

Angela stared at the Moor, her eyes shining.

"That is from my book," she commented.

"That is where I read it. Your reasoning is without fault. Dangerous, perhaps, but without fault."

Angela gestured to her own sewing.

"I have been slowly building just such a flight engine for a month past. What I am sewing just now is the left wingtip. Ah, but I shall have to abandon it now. In a year it would have been finished, then fly I most certainly would have."

"And died, perhaps."

"Sir Philip and Baron Raimond ventured into the borderlands of death when they dueled, but nevertheless returned."

"Have you no gratitude to Philip?" admonished Alren.

"No more than his late wife had."

"What do you mean?"

"Sir Philip believes that pain drives out evil. He has himself whipped every day by a well-muscled young squire. He used to whip his wife before he went abed with her, so that the evils of lust and passion would be driven out of her before the holy act of procreation. One night he apparently purged the evil from her rather too enthusiastically. She died,



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yet the Church praised Philip as a pious and holy man, and did not punish him. You can imagine what would happen to me if I were to become his wife."

Alren shook his head.

"Had Sir Philip won, you might have felt differently."

"Had he won, I would have kept the drawbridge up. Wherever I turn, death awaits me."

"What of Raimond?"

"Raimond is brave and clever, but misguided. When he courted me, he tried to impress me with martial victories, not comprehending that a short, scholarly tract on the nature of feathers would impress me more. The man wastes himself on wars and tournaments—and sieges. Alren, Alren, tomorrow I shall die and there is nothing more certain. As soon as the first stone ball from Baron Raimond's trebuchet smashes into my tower's walls, I shall order the gates open, the barbican's drawbridge lowered, and all arms laid down. Then I shall leap from the top of the Tower of Wings wearing my plunge cape. It is but a poor substitute for a full-sized flight engine, but it is all that I have."

"It may very well not work, excellent lady."

"In that case, death by falling from a great height is a great deal quicker and less painful than death by being burned alive. Before that I shall burn my books before the bishops get the chance."

"Why, excellent lady?"

"Sheer spite."

"Excellent lady, I wish I could help."

Quite suddenly, Angela knelt down, put a hand beneath his chin and kissed him upon the lips. Alren gasped and pulled away, dropping the almost completed harness.

"Excellent lady, this is not seemly!" he exclaimed. "Your honour would be tarnished."

Angela sat back and hung her head, staring at the rug on the floor.

"Of all the men in my life, why is it that only an elderly, dying friar and a pious but heathen Moor have been able to win my regard?"

Alren clasped his hands and shook his head miserably.

"I cannot say."

"Alren, tomorrow I shall die. Should you wish it that I not die a virgin, you alone may visit my bedchamber tonight."

"I—I wish it, excellent lady, but honour forbids it."

Angela sighed, rested her elbows on her knees and her chin on her clasped hands. A tear ran down one cheek.

"Is there indeed anything I can do for you? Being a Moor, you may be treated badly when the tower falls, but you can escape tonight. My people can get you over the walls and across the moat. After that, the villagers will hide you."

"It is you who should flee, excellent lady."

"No, if I escaped, the English would begin to slaughter those in the tower until I returned," she sniffled, tears now on both cheeks. "Nobody will know about you."

"Excellent lady, may I take your books?"

"My books?" she asked, looking up.

"Raimond and the bishops will surely use them against you, then burn them anyway. I shall take them back to Spain so that at least Moorish scholars may remember you."

Angela stood up. "Then take them and go, and take my blessing too. I shall make the arrangements for your departure."

Baron Raimond was roused an hour before dawn, and Alren was shown into his tent. The Moor had a pack on his back, and was dressed as a pedaler.

"I expected you earlier," said Raimond.

"I had to secure her books," replied the Moor. "It was not easy."

Raimond watched as Alren unpacked Angela's life work. He flicked through the pages by lamplight.



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"It is as I remember," said Raimond. "Enough to send the bishops reaching for the brushwood and firebrands."

"I am glad to be away from her," sighed Alren. "For a year I have been in her confidence. I have been her friend, welcomed every time I have visited the Tower of Wings to study her writings. The strain of deception has been heavy upon my conscience."

"And I am grateful for your trouble, my loyal and faithful conspirator."

The throwing arm of the trebuchet stood almost vertical, towering over Raimond's camp as Wat inspected it in the cool morning air. Satisfied, he nodded to the trebuchet captain, who gave an order.

A dozen men pushed at the levers of the trebuchet's windlass. The ratchet clacked rapidly at first, but as the arm began to depart further from the vertical, the work became harder. After ten minutes, the heavy box of stones that was the counterweight had risen several feet, and the throwing arm was horizontal. Wat paced around the huge, wooden machine again.

"No cracks, no warping," the captain declared proudly.

"There had better not be," Wat replied.

"Where is the baron? I had thought that he would want to command this engine himself."

"The baron is busy elsewhere. There is more to breaching a castle than smashing the walls. You have been named to carry out his instructions."

The team continued to wind. Within another ten minutes, the throwing arm's head was nearly touching the ground. A sling containing one of the stone balls was hooked to the arm, then a rope was tied to the release catch. This rope was handed to the captain as trumpets blared a fanfare. The captain gave the rope to a team of peasants.

"Clear the surrounds," ordered Wat.

The men of the windlass team hurried to one side. Everyone else was already clear.

"At your word," said Wat to the captain.

"Have the trumpets sound a warning."

The trumpets brayed another brief fanfare. The captain raised his hand, then brought it down sharply. The team of peasants hauled at the rope attached to the release pin. The pin clinked free, releasing the throwing arm. The box containing twelve tons of rocks descended, hauling the throwing arm around with a mighty creaking of joints and axles. The whole trebuchet rolled forward as the box came down, then back as its centre of gravity passed behind the axle, then forward as it returned again. The sling was whipped around, flinging the sandstone ball in a great arc and releasing it. The three-hundred-pound ball hissed through the air, rising high and dark against the blue sky, then thudded into the rich turf twenty yards to the left of the outer wall of the Tower of Wings, and a yard short of the abandoned cart. Those in Raimond's camp cheered.

"A miss!" shouted the tower's seneschal, and the men at arms with him cheered.

"He aims at the cart!" retorted Lady Angela impatiently. "Had he been aiming at the outer walls he would have struck true the very first time."

They were standing at the top of the Tower of Wings, and had a better panoramic view of the proceedings than anyone else. Already the arm of the trebuchet was being wound down again by the windlass team.

"So, he means this just as a warning?" said the seneschal.

"Yes, and if I do not heed his warning he will soon bring that thing to bear on the walls. See that long, light ramp behind it? He must mean to use it to span the moat. This is the end."

"There is always hope while—"



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"Get two servants, and carry my trunk up here."

"My lady, you cannot mean to do this!" exclaimed the seneschal.

"Need I repeat my order, Stephen?"

"No, my lady."

The trebuchet took twenty minutes to wind down again. A maidservant was buckling Lady Angela into her harness as the distant trumpets sounded, and they all turned to the south. The mighty machine's arm swung up as the box dropped, and the trebuchet rolled forward as a second stone ball was flung into the sky. It rose in a smooth arc, almost like a feather lofted by a strong wind, then descended. There was a heavy thud as the cart was smashed apart into a cloud of fragments and splinters. Again the English besiegers cheered.

"That was only his second cast," said the seneschal. "Why, with such accuracy he could choose which individual stone he wanted to hit in the curtain wall."

"Or put a stone ball through my bedchamber window," muttered Lady Angela.

"They are winding the arm down for a third cast," said the seneschal.

"The baron has issued his warning," said Angela grimly as she climbed up between the crenelations at the edge of the tower. "The next cast will be to show what he can do against stone walls. Secure the cords to my harness, and tie good knots. After that, hold out the plunge cape to either side of me, hold it high, spread out over the edge of the tower on pikes, as I have shown you."

Beside the trebuchet, the captain was shouting for the attention of his cheering, dancing crewmen.

"Back to work, ye buggers! Shoulders to the windlass!"

Wat put a hand on the captain's shoulder and gestured to the ramp.

"That proves it holds together and casts true. Now we'll use the master's special missile. I'll uncover it and fasten the tether."

They stood ready, Lady Angela crouched between the crenelations while her people held the plunge cape spread above her like a huge, green awning. In the distance they could see men tending something on the ramp that had been built behind the trebuchet. It was a red thing, luridly bright red. In the summer heat it seemed to shimmer like . . . flames.

"I do believe they mean to cast a fire missile next," said the seneschal.

"A burning oxhide filled with oil," cried Lady Angela. "It will burst in a carpet of fire, it will kill dozens."

"No, the trebuchet is still aimed wide. He means to smear fire all over the fields before us, to frighten us into surrendering."

"Well, then, after I jump, surrender the tower. Not a single one of those fire missiles must come over the walls."

The trumpets blared again. Lady Angela whispered a brief prayer and clenched her fists. The arm of the trebuchet swung up, the machine rolled forward—and something huge and red was drawn up the ramp, something far wider than the trebuchet, something with vast, red wings that rose up into the clear air more steeply than the heavy stone balls. The tether slipped free and the flight engine continued to ascend in a steep, impossible trajectory. Lady Angela very nearly fell from the wall in sheer surprise. From below and behind her came cries of amazement, while cheers echoed across the fields from Raimond's camp. The device had shot straight out of the pages of her book on flight.

Strapped into the wicker cradle of the flight engine, Baron Raimond was aware of no cheers, only of the air buffeting his face, hissing through his hair and roaring in his ears while the horizon tilted



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and rocked before his eyes. Off to the right and below was the Tower of Wings, suddenly presented from a totally alien perspective. He was within bowshot, in spite of his speed and height. Lady Angela had ordered that no archer of hers should ever shoot at anything flying, yet did that order extend to him?

The ground was a patchwork of greens. He had never realised that the countryside looked like a quilt until he had flown. Everything seemed to be moving slowly, yet it was only because the ground was so far away. Even on the fastest horse that he had ever ridden, the air had never moved past so rapidly. *When I come down I will still be moving as fast*, passed through Raimond's mind. His heart was hammering, his mouth was dry. This was the heady thrill of battle, the intense fright of charging another knight in a tourney, this was knowing that death was at his shoulder, kept from claiming him by no more than some red silk and wicker. In a sense the flight engine was not hard to control, it practically flew itself. A warhorse was more difficult to ride, yet a warhorse was slower and closer to the ground. The world seemed so far away that no sounds reached him but the wind in his ears, yet everything that he *saw* was quite stark and lurid. This was his third flight, yet he had not noticed the effect before. *A bird needs eyes more than ears while in flight, perhaps our ears become dormant while we fly*, he thought.

Suddenly realising that he was past the Tower of Wings and descending, Raimond pushed back against the right control cord with his foot, raising a flap at the right wingtip. The flight engine began curving around, circling the Tower of Wings. At its summit were several figures holding a large, green awning over the side, just as Alren had warned. Fields, trees and hedgerows passed below. Newly shorn sheep, intensely white against the green fields, scattered as the monstrous shadow passed over them. He was only twice the height of the tower's summit by the time he had turned back upon his initial path, and in the distance was the trebuchet, the mighty siege engine whose twelve tons of counterweight had given his flight engine its speed and flung it into the sky. He continued to turn, circling the tower again. The green awning was still there but was now just draped over the edge, and the figures were watching and pointing. Other tiny, dark figures swarmed about the walls, barbican and bailey, like ants disturbed by a boot on their nest. The flight engine was still performing well, but there was the matter of landing to attend.

Raimond was still high and fast enough to return to his camp, but that was not his intention. As he caught sight of a clearing ringed with trees that he had scouted days earlier, Raimond reached under his wicker cradle and tugged at a cord, spilling sand from a sack fastened beneath him. Very quickly the prow of the flight engine tilted up, and it began to lose speed and drop. He descended below the level of the treetops.

Angela watched the flight engine vanish from view, the harness of the plunge cape now discarded at her feet.

"The flight engine turns purposefully, as if being guided," she whispered to herself. "Someone must be riding upon it."

Pushing his feet against the cords controlling the wing flaps, Baron Raimond straightened his frail craft, glanced at the grassy ground rising up to meet him with familiar but terrifying swiftness, then felt the wickerwork skid scrape turf, bouncing the flight engine back into the air before it came down more gently and slid to a stop. It tilted over onto its right wing as Alren came running over to unfasten the buckles that had held the baron secure during the flight. Raimond was drenched in perspi-



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ration.

"Must return," he stammered as the Moor helped him to his feet.

"Excellent lordship, your horse is behind those hawthorne bushes. Are you sure you can ride?"

"Ride, yes, walk, no. If you please, help me to my mount."

The baron set off at once, leaving Alren to guard the clearing and flight engine. As he reached the trebuchet, the news arrived that the Tower of Wings had surrendered, and that the drawbridge was being lowered.

"You have your tower, sire, undamaged," Raimond said to Edward.

"Yes, they have capitulated!" exclaimed Edward. "Why?"

"Because Angela is a lady of great scholarship, and I flattered her by building that device. With the rest of the Scottish castles, we *shall* have to smash the walls down, however. There is now, ah, the matter of . . ."

"Yes, yes, I shall deal with the bishops."

With that, Raimond reeled, nearly fell, then dropped to his knees and vomited at the feet of his king. Edward helped him back to his feet.

"Raimond, you are soaked with sweat, pale and exhausted, trembling like a new-born foal even though there has been no fighting," said Edward. "You flew on that thing, did you not? You hid within the long wicker basket and flew."

"Between us alone, sire, yes," said Raimond hoarsely.

"What was it like?" asked the king eagerly.

"Death's hand rested upon my shoulder while I was aloft, I felt the chill of his fingers like knives of ice."

"I would like to know the feeling, Raimond."

"No, you would not, sire."

By the time Lady Angela rode across the drawbridge, Baron Raimond was waiting to greet her. Dismissing their escorts, they rode away together, alone, and initially in silence.

"You brought my theories to life," Angela remarked guardedly as they reached the trees. "You are indeed remarkable."

"Not so, my lady. My friend Alren the Moor studied your work and helped me render your designs into silk, pine and wicker."

"Alren!" exclaimed Angela.

"Given the circumstances, we decided it was not wise to reveal just why he was studying in the Tower of Wings."

"Understandable," replied Angela frostily, her eyes narrowing.

"I provided the gold to build the devices, and—Ah, and here is the engine itself, with Alren standing guard."

Alren was standing beside the flight engine, but he avoided Angela's eyes as she dismounted. She put her hand out to grasp a wing, but being lighter than she realised, the flight engine swayed alarmingly. She drew back, worried that she might have damaged something.

"By trial and error we learned to build much lighter and stronger than your drawings specified," explained Alren. "And we used flexible wicker joints so that the wings would bend instead of being torn off during the launch."

"At first we launched it weighted only with sandbags," added Raimond. "There were crashes, but presently the engine flew straight and gently."

"But today the flight engine was being controlled!" said Angela firmly. "Somebody was lying within the wicker cradle. Alren, it was you, it must have been you."

"Ah ha ha, but I have no courage for such feats and adventures, excellent lady. It was Baron Raimond who flew both trial flights, then again today."

"Raimond, two flights?" echoed Lady Angela, staring at the baron.

"You witnessed the third," said Raimond.

Lady Angela turned back to the silken wing, running her hands over what she could scarcely bring herself to believe could exist.



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"So much risk . . . but why?"

"Why, to win your favour, my lady. Compliments, feats of arms and jewelry cannot move your heart, that is well known. Thus I complimented you by bringing your design to life. Rather than trying to prove my bravery in battle, I flew your flight engine instead."

"Oh, and instead of jewels you give me the completed flight engine," said Angela hopefully, caressing the wing teasingly instead of falling into Raimond's arms.

"Ah, that and more. Instead of jewels, I give you the *idea* of launching flight engines with a trebuchet. I am not sure that any man has ever given his beloved an idea as a gift before. Are you pleased?"

Lady Angela stared past Raimond for a moment, her eyes unfocussed, then she put a hand above her left breast, swallowed, then gasped loudly.

"Are you not well, my lady?" asked Raimond, full of concern.

"It is no serious matter, my lord," she said, now smiling and without guile. "My heart has just been moved, and the feeling is quite new to me."

Raimond felt as if his body was a fist unclenching. He knelt in the grass, took Angela's hand and kissed it.

"Edward Longshanks was delighted when I delivered the Tower of Wings to him without loss of life or damage," explained Raimond, still holding her hand. "He will shield you from charges of witchcraft, he gave me his word on it."

"Which is more than my fellow Scots would do for me," snapped Angela, her annoyance undisguised. "My lord, thank you indeed. In all the world I thought it impossible such a man as you could exist, yet . . . here you kneel before me. For me you studied, for me you flew, and most incredibly of all, for me you actually thought."

She drew him to his feet and at last they embraced, standing beside the red, silken wing of the flight engine. Alren stood with his arms folded and his back to them, his face impassive. Presently Raimond rode off to fetch men to dismantle and carry away the flight engine. While she and Alren waited, Angela made a pretense of examining the wingtip flaps.

"Did—did you tell him?" she asked.

"Tell him what, excellent lady?" asked Alren, his back still turned to her.

Angela rocked the wings in a parody of flight.

"About . . . that I weakened."

"Did you want me to tell him?"

Unable to allow herself to approach him, Angela brushed her lips against the silk wing that his hands had helped to fashion.

"In all of England and Scotland, only Raimond could teach you anything of chivalry, most gallant Moor. Keep my books when you return to Spain, and my blessing as well."

* * *

Alren returned to Spain after the Tower of Wings was surrendered, and he took with him Angela's books and his own notes and account of the siege. Until Alren's archives were rediscovered in 2003, there was nothing known of the quite fantastic achievements of Lady Angela, Baron Raimond and Alren himself. Alren died of a fever only months after returning to Spain, and from the end of his chronicle of the siege there are very few details.

We know that Angela and Raimond were married late in that same summer. They had two children, and quite probably lived in happiness until August 1305, when Angela died from what a chronicler of the time described as 'a most heavy fall.' Raimond died at Bannockburn in 1314, when the English knights were routed by King Robert the Bruce and his Scottish pikemen. When Alren's manuscripts came to light, I ordered the family tombs opened in the hope of finding more of her books buried with her. None were there, but examination of her skeleton revealed that her death had



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resulted from an impact that had caused a total of seventeen fractures. I think it is beyond doubt that she died in the crash of the flight engine designed by her and built by Raimond and Alren. Even at a distance of thirty generations, I still feel pride when I read the chronicles of my distant ancestor and look at her designs. Each time I read of what Raimond did to win her love, it brings tears to my eyes.

Historians are currently debating why all traces of the flights were sponged from the contemporary chronicles so completely? We can only speculate about what must have happened, but my theory is that after Angela's death, Raimond did not want their children to grow up with dreams of piloting flight engines that might one day kill them. All her remaining notes, drawings and devices were probably swept from his castle and burned with the wreckage of the flight engine. Servants were forbidden to speak of flying, and the two boys are known to have been sent to court and brought up to be models of medieval nobility. The Church was certainly not interested in documenting the works of someone considered to be a witch, so soon the tale of the siege was told only by villagers and soldiers. Generations passed, it slipped into folklore, then faded into stories about witches flying on broomsticks.

Until now.

Many modern scholars have questioned the truth of Alren's chronicles, branding them allegory, wishful thinking, or just plain lies. These people lost credibility when Angela's skeleton was found wrapped in red silk and lying in a long, narrow basket which showed severe damage. Others questioned the designs themselves, saying that the plunge cape would need a drop five times the height of the Tower of Wings to open fully, that being launched by a trebuchet would tear a flight engine apart, that the craft would not be stable in flight, that the materials would be too heavy, that a medieval warrior such as Baron Raimond would not have had the piloting skills to fly it twice around the Tower of Wings, or that nobody could have landed the flight engine without being killed!

Some of them were proved right. A month ago, the carcass of a pig about the weight of a human was pushed from the summit of the tower strapped into a reconstructed plunge cape, while six people with pikes held the fabric out. The carcass dropped straight to the stone courtyard before the plunge cape could open properly, and its neck and spine were broken. The bigger the plunge cape, the further it has to drop before opening. Lady Angela would have died had she jumped, there is no doubt of that. Dropped from a helicopter, however, the device opens and flies like a primitive para-glider after falling five hundred feet. It is actually becoming fashionable with skydiving clubs, and people even dress up in medieval costumes before using it. The flight engine is a different matter. Models of it glide surprisingly well, but land too fast and heavily. There is also the issue of whether being launched from a trebuchet would tear it apart, and of whether it could be flown by an untrained pilot such as Raimond.

All of that is about to change. It is just after dawn on July 11th, 2005, just a month from the seven hundredth anniversary of Lady Angela's death. I am standing before the Tower of Wings, and behind me is a reconstructed trebuchet, capable of hurling a three-hundred-pound stone over two hundred yards. Behind the trebuchet is a ramp, and on that ramp is a full-scale flight engine, built to the specifications of Lady Angela and Alren the Moor. I can ride a horse, but I have never had a single flying lesson. I am also clothed in a medieval costume so authentic that I am not even wearing a bra.

I believe that the flight engine will survive being launched, that I can control it in flight, and that I can land it gen-



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tly by dropping enough sand ballast to raise the nose and shed speed. Even if the worst happens and I crash, however, I am sure that my skeleton will show the same pattern of fractures as Angela's bones display, and she will be proved to be the first woman to have flown. My MBA lecturers would have called it a win-win situation for my distant ancestor. Instead of flying in secret, however, the cameras of the BBC, CNN, National Geographic, and dozens of other sponsors are already following my every move, and at dawn the prayers for the success of the flight were led by an Anglican bishop. Times have certainly changed. Most notably of all, it is now a woman who is about to be flung into the sky in defence of Lady Angela's honour. In 1303, this would have been unthinkable, yet even this supports her place in history. At the dawn of that ancient century, a woman should not have been able to look from a window in the Tower of Wings and dream of wings made from silk, pine and wicker, yet this was her greatest triumph.■

## IN TIMES TO COME

A new novel by Robert J. Sawyer is always a special treat, and we're very pleased to announce the beginning of *Hominids* in our January issue. There was a time when two kinds of humans, ours and Neanderthals, shared the Earth. Now there is only one—but what if it had been the other? And what if *both* options happened in different parallel universes, and one made contact with the other? There's a lot we don't know about Neanderthal men and women, but it's a fair guess that, given the opportunity, their civilization would have developed quite differently from ours; and the contrasts between some of our other primate relatives may suggest what the differences might have been. Needless to say, they would pose big challenges for the hominids on both sides of the rift, and Sawyer tells quite a story about the results.

Wil McCarthy offers a fact article with the tantalizing title of "Beyond the Periodic Table: Artificial Atoms and Programmable Matter." It means what it says; it isn't *quite* as far out as the quasimaterials in my novel *Newton and the Quasi-Apple*, but it's surprisingly close—and it's real!

We'll also have a diverse assortment of stories by writers including recent Campbell nominee James Van Pelt and the new duo of Larry Niven and Brenda Cooper, plus the complete Index to our 2001 issues and the ballot for The Analytical Laboratory. This, as many of you already know, is your annual chance to return a tangible reward to the authors and artists *you* found most rewarding, and to give us valuable feedback and guidance on what you'd like in the future. So please vote; it's important to all of us!



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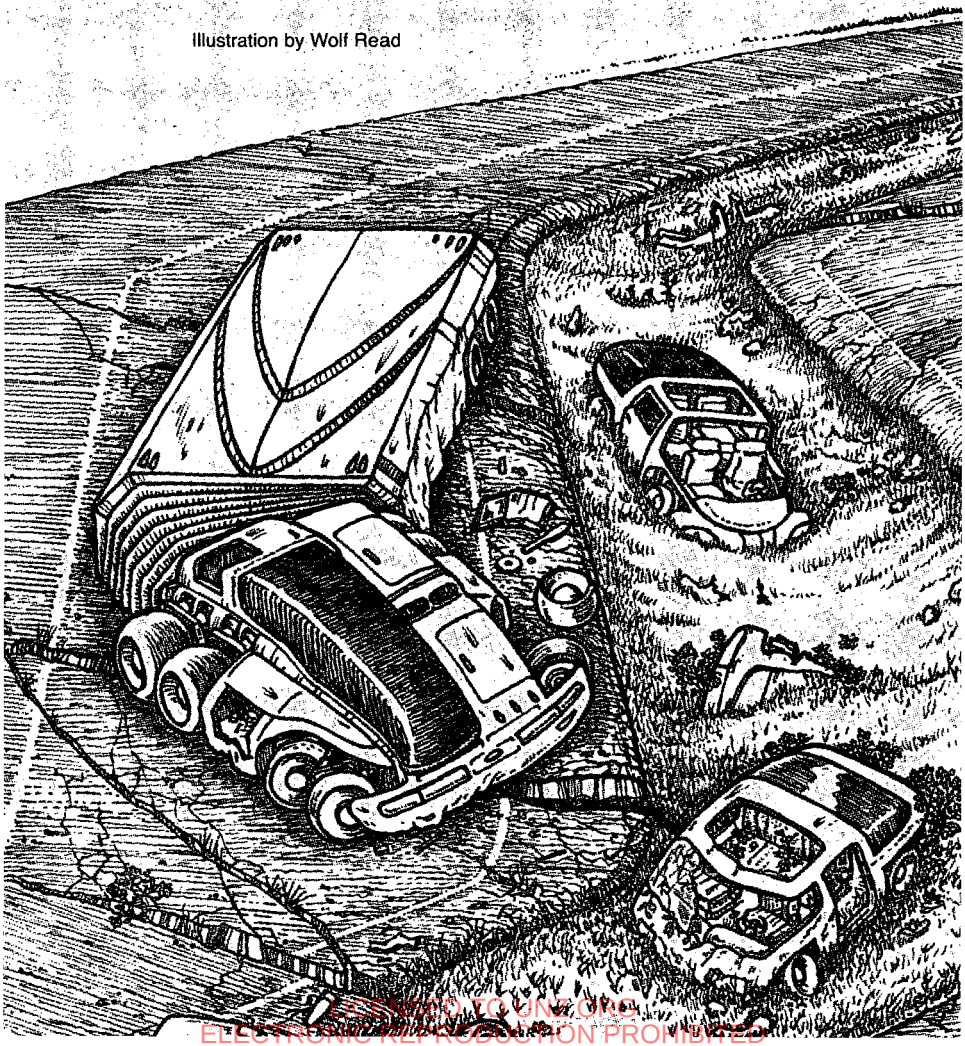
# First Contact National Monument

## Rick Shelley

**Major turning points can be big and dramatic—but they don't have to be.**

Illustration by Wolf Read



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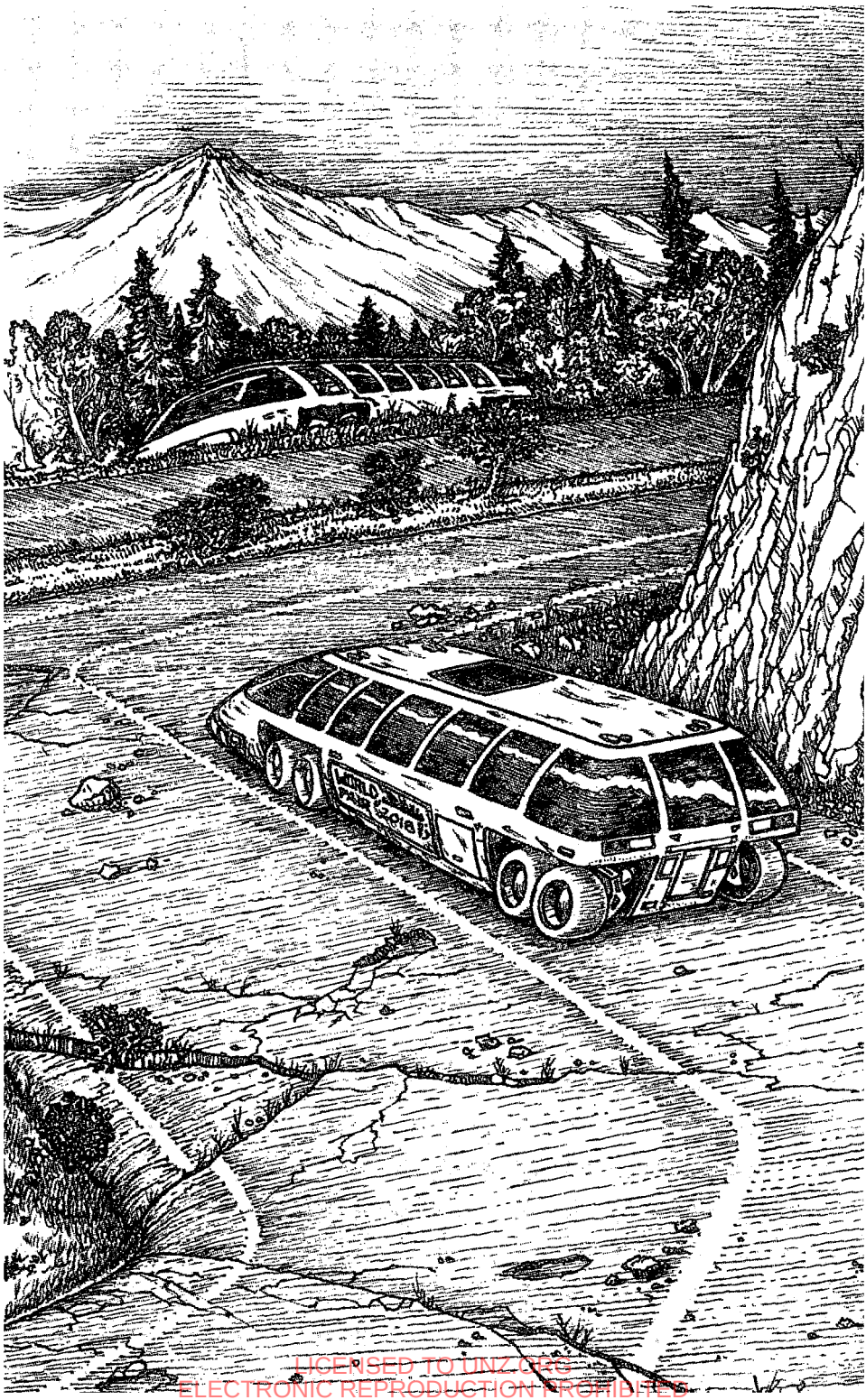

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The bus was a decade older than I am. It needed three days to get from Atlanta, Georgia to Asheville, North Carolina—two breakdowns and one flat tire. Each time something went wrong, we had to wait for a repair truck. One wait stretched fifteen hours. There were no spare buses. This one only continued to run because others had been cannibalized for spare parts. Maybe it will last as long as the highways. Those we traveled weren't in great shape. Most had been neglected for decades, full of potholes and cracks, with grass growing through them.

The mountainous stretches of the ride were an adventure, more frightening than rollercoasters were when I was a boy who found excitement in fear. There were curves where we could see rusting carcasses of dozens of vehicles that had gone over the side. The stretches along the lower terrain were merely bleak and disheartening. It was early May and already fields and lawns had the burned-over look of August. Several streams we crossed or paralleled were dry ditches. In some areas, even the dried-out weeds had blown away, leaving only fields of dust that would grow nothing.

Eight passengers started the journey. Two elderly women got off in Spartanburg, South Carolina. An elderly man died during the final night, his death unnoticed until daylight, two hours before the bus limped into Asheville. The corpse rode the rest of the way with us, a ratty old blanket over him the only special consideration.

I had to wait for the clerk in the Asheville depot to arrange for the coroner's office to come for the corpse before I could ask about my connection through Knoxville, Tennessee to First Contact National Monument in southeast Kentucky.

He shook his head slowly while he stared at my ticket. "I'm afraid it won't be leaving until tomorrow at the earliest, Mr. Clayton. The regular bus on that run went off the road in the mountains near the turn-off to Cherokee, so we'll have to use the bus you came in on, and the driver tells me the transmission and engine need work. Anyway, the driver needs a full night's sleep before he can go on the road again." He handed my ticket back to me. "Sorry."

"Don't suppose there's much you can do about it," I said, trying to keep from sighing out loud. "I thought I gave myself enough time. I need to be at First Contact by the sixteenth."

The clerk looked at me as if he wanted to ask why, but he didn't.

"Is there somewhere close I can get a cheap meal?" I asked. The station didn't have eating facilities—or much of anything but the ticket counter and two ancient wooden benches.

"Three blocks down." He pointed. "Emma's Eats; next to the Mountain Inn Motel. Emma's a pretty fair cook. And the motel is clean."

"You keep the station open all night?" I didn't want to waste what little extra money I had on a motel. I had no idea how long it would be before I could get a little day work and it would be six weeks before my next annuity check arrived . . . in Atlanta. Getting funds transferred to wherever I was then might take another week. At that, I'm one of the lucky ones. I can always count on that check—$675 every three months. It goes a lot farther now than it used to. Prices have come way down, for about everything but petroleum.

The clerk shook his head again. "We're open two hours before a bus is due in or out and only as long as necessary after that. And there isn't anything due until this bus leaves. Have to lock up. Company rules."

This time, my sigh escaped before I could stop it. Well, after three days in that bus, I *did* need a shower, and a night in a real bed might ease some of the aches of bus travel.

"Motel's right next to the diner?" I asked. The clerk nodded. "Thanks. I'll



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see you tomorrow."

May 16 was the fiftieth anniversary of the alien landing on Earth, five years to the day before I was born. That coincidence has always haunted me, as if it had cosmic significance. The longer we went without hearing from those aliens again, the stronger the feeling got. It isn't logical, and might not be entirely sane, but that's why I was headed toward the landing site. *Something* in my head kept telling me I *had* to be there for this anniversary.

It was May 9th when I reached Asheville, with the hardest stretch of the trip left, across the Appalachians and the Cumberland Gap. I don't know why the aliens chose southeastern Kentucky rather than any of the thousands of "more suitable" places. They didn't say.

There was a lot the aliens didn't say. The biggest was when, or *if*, they would return. Everyone assumed it was the first contact of many, our introduction into whatever galactic civilization exists—especially since the aliens left that robot behind to roam around. They asked that no one obstruct it, or interfere. I suppose we were afraid to, though there were a lot of suggestions that we take it apart to see if we could learn more about the aliens. When they came back, we had to have the robot intact or be willing to face whatever . . . repercussions might come if it wasn't.

I had no idea where the robot was. I couldn't recall the last time I had seen anything on the news about it. After half a century it was no longer *news*, its comings and goings reported routinely, like the weather.

What brought the robot to mind that day was that someone had taped a photograph of it to the wall of my motel room. The machine was a seven-sided can, thirty inches tall and twenty inches in diameter with a series of wheels and rollers that supposedly let it traverse any terrain. It had a variety of sound and video recorders as ears and eyes. The edges of the photograph were curled and brown, but no one had ever removed the picture. I didn't bother either.

I took my shower and put on clean clothes, rinsed out the clothes I had been wearing and hung them over the shower curtain rod to dry, then went next door to the diner.

Emma didn't bother with a menu. She fixed whatever she had and that was what you ate, and what you had to drink was water or ersatz coffee. Emma looked about my age, though she had more gray hair—small and frazzled in appearance, with a vacant look in her eyes, as if she never really saw anything or anyone, and a grayish cast to her skin.

"You doing OK today?" she asked when I entered and sat at the counter. Her voice was low-pitched and husky-sounding.

"Getting by," I said. "Hungry. You doing OK?"

"Fair to middlin'. We got stew and biscuits today," she said, so that was what I ordered, with coffee. The food was ready as soon as Emma ladled the stew into a bowl. She put two biscuits on a napkin and set that in front of me. The coffee tasted more of pine nuts and pecans than coffee, but it was far from the worst I had drunk over the years.

Emma watched while I sampled both stew and biscuits. The stew was heavily salted but that gave it needed flavor. I suspected I was better off not asking how long the stew had been stewing. I noticed there was no black pepper on the counter and didn't bother asking. You pay extra for pepper, when you can get it.

"You come in on the bus?" she asked after giving me time to take the edge off my hunger. I nodded, then washed down a mouthful of biscuit with ersatz coffee. She grinned. "'Cept for my regulars, folks traveling through by bus are about all I get."

"I'm glad you're here," I said. "I was afraid I was going to have to eat my pil-



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low."

She gave me a bigger laugh than I deserved. "You coming here or just passing through?"

"Passing through," I said. "Going to Kentucky."

"You got kin up there?"

"Not that I know of." After a slight hesitation, I added, "Don't have kin anywhere I know of. Going to First Contact." There was no reason why I should tell her, but it's nice to have someone to talk to now and then. As much time as I spend on the road, it's talk to strangers or to myself. It's not like I had anything to hide.

"My daddy took me up there when I was a little girl, just a year or two after they made it a national monument. I guess it's changed some since then to get what they can from the tourists. You been there before?"

"Twice. The last time was ten years ago." On the fortieth anniversary. I stayed three weeks, the same length of time the aliens spent on Earth. "Must be the only place left in the southeast where they still get tourists with money."

"You don't look much like a tourist."

I shrugged. "Maybe not. Don't know what to call myself sometimes. Something just keeps dragging me that way. I guess one place is 'bout as good as the next."

"Ain't it the truth," Emma said.

The clerk from the bus station came in. He ordered coffee, and waited until Emma served it and he had taken a long drink before he turned to me.

"Bad news, Mr. Clayton," he said. "Be late tomorrow afore that bus is ready to go, if then. I gotta find a part. If I can't find it here in town, I might have to ride up to where that other bus went off the road and see can I salvage the part from it. If I do, be the day after tomorrow, maybe longer."

"Any other way to get to Knoxville without walking?"

The clerk thought it over, then shook his head. "This time of year, might be a week before a freight train heads that way. An' the few trucks goin' through, won't none of 'em take a rider. They're awful tight on that. More like to get shot for askin'."

"I know." I might hop a freight if I had to. It's not comfortable, but they usually don't hassle you. "If I'm stuck here longer than tomorrow, I'm going to need to do some work to get by. You know anyplace likely?"

"Not offhand. Emma?"

"Ain't heard nothing. But I got any food left come closin' time, you can always get a meal and owe me, Mr. Clayton."

"Thanks, Emma. Folks call me Woody, most times. You're good people."

"Well, Woody, the Lord wants we should help each other. Anyone can need a hand now and then. You get real hard up for a place to stay, the church over to the next block sometimes lets folks sleep over a night or two. I can talk to the preacher, let him know you're OK."

I smiled wider. "Thanks again, Emma. I'll let you know."

The clerk's name was Taylor Garner. He didn't stick around long; said he had to get busy looking for that part. I chatted with Emma for an hour, finished my stew and the free refill she ladled out, along with more coffee. I wasn't eager to go back to that motel room and Emma seemed to like having someone around. There weren't any other customers. When it got close to her closing time—four in the afternoon—I offered to help with the cleaning and she took me up.

I didn't head directly back to the motel when I left the diner. It was hot and the motel didn't have air conditioning. I walked around, just looking to see what was in the neighborhood. Not much. Four of five stores were vacant; entire blocks were deserted. On one street, five blocks off, there was a row of empty fast



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food places and gas stations. From the look, most had been closed for many years. It's been twenty years since anyone was allowed more than two gallons of gas a month for a private automobile . . . when any gas was available. A person could eat all month on what two gallons cost.

A lot of cities are pretty much deserted in the old business districts. Any "life" remaining would be on the outskirts, and even there it might be sparse. I've heard that even in the middle of New York City there are blocks on blocks of skyscrapers standing empty, decaying. I know it's that way in Chicago. I was there four years back.

Before the Sun got too low, I headed to the motel. I wasn't familiar with Asheville, but some towns are rough on transients on the streets after dark. I didn't want to press my luck.

It was still hot in my room so I opened the window, then sat on the doorstep with the door open, hoping to get a little breeze through. Sleeping would be easier if I could get the temperature inside below eighty. There weren't any other guests at the motel. The place was run by a husband and wife. They slept behind the office. Neither had been talkative.

After a time, I leaned against the doorjamb and closed my eyes. I was drained near to empty and almost fell asleep sitting there. Before I could, I went inside—locked the door and shut the window. I didn't have much, but there might be others with less—and fewer compunctions about how to get more.

I woke not long after dawn, soaked in sweat. I got out of bed, still tired, and paced the room trying to decide what to do. It was far too early to go to the bus station to ask whether there was any chance of getting out of town that day. Emma wouldn't open until eleven o'clock. I could waste a little time taking another shower, but I wanted to postpone that because this day might be hotter than the day before and I could use the cooling a shower gave me better later.

There was no radio in the room—electric lights had been almost a surprise—and I didn't know how far I'd have to walk to find a newspaper—if Asheville had one. I thought of asking about a library. There was sure to be one of those. But a library wouldn't be open that early either.

I got a washcloth wet and ran it over every bit of exposed skin to get a little cooling. I stood at the window and watched the street. No one went by in fifteen or twenty minutes. I leaned my forehead against the glass and closed my eyes. Maybe I stood there like that for another ten minutes. I hadn't had a watch in years, and I'm no good at guessing time.

It must have been eight-thirty or nine when I left the room. I didn't bother taking my suitcase. Until I found out whether the bus was going to leave that afternoon, there was no point. I decided I could afford one more night in the motel. If I had to wait longer, I'd look into that church.

I walked for a while, going in a different direction than I had the afternoon before, but finding pretty much the same situation. One pawnshop was open, but I didn't have anything left to pawn. Eventually, I reached the bus station. The bus was in the lot—engine compartment open, pieces sitting on the pavement—but no one was working on it. Taylor wasn't around and the depot doors were locked.

I stood in the shade between the bus and the building for a time. I was about to leave when I noticed movement inside the bus—just a quick thing, a blur along the bottom of a tinted side window. I stared hard at that window, and at the ones on either side. Was someone inside? Maybe Taylor or the mechanic? I couldn't see the door from where I was standing, so I moved until I could. The



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bus door was shut. Since I didn't have anything else to do, I waited, scanning the windows, wondering if perhaps I had imagined something moving.

Then I saw movement in the bus again. I didn't know what to do. The smart thing would have been to walk away. Most times, curiosity is more trouble than it's worth. It was none of my business if someone was in there, but the most likely explanation was that it was Taylor, the mechanic, or the driver. Any of them might be able to tell me if there was any chance of the bus leaving that day, and that was something I *did* want to know.

Indecision made my decision. The bus door started to open and it was too late to inconspicuously absent myself. I took a couple of steps back, closer to the building, but shade wasn't shadows and whoever came out of the bus was virtually certain to see me. I remained motionless. I might even have held my breath.

That it was a young woman who stepped out was neither a surprise nor a relief. A woman up to no good can be as dangerous as a man. I guessed she might be in her mid-twenties, but could have been off by five years on either side. She was about five feet six inches tall with nut-brown hair pulled back in a ponytail. Although the shirt and trousers she was wearing were baggy, I had the impression that she was slender, even skinny. For maybe two seconds, I thought she might not notice me, head the other way without looking toward me. But she did look, and the way she jumped startled me half out of my wits.

"You're not the bus clerk," she said. "Are you the driver?" Her voice had a tinny edge, maybe frightened. Her body language didn't speak of fear, though. She leaned forward aggressively, as if she were ready to charge me if my answer wasn't right.

"No, I'm just a passenger, if they ever get the bus running. What'd you do, sleep on it?"

Her eyes narrowed—they were a darker brown than her hair—and she edged farther away. "What business is it of yours?"

"I just wish I had thought of doing that. Could have saved myself three bucks for a motel room." Maybe she had been in the bus to see what she could rip off, but maybe she just had no place else to sleep and thought an unattended bus was better than an alley or a vacant building. "If you're planning on riding this bus, you might have a long wait. The earliest it might leave is late today, and the clerk said it might be another day or more if he couldn't find the parts they need in town."

By degrees, she appeared to relax a little. It wasn't until she settled flat on both feet that I realized that she had been poised to run if necessary, almost on her toes.

"By the way, my name's Woody Clayton." I didn't stick out a hand or anything, afraid I might spook her. She continued to stare at me. I wasn't sure what she was so nervous about—other than the routine dangers of staying alive and in one piece—but *something* had her wound two turns too tight. I thought it was more than the fact that I had discovered her where she shouldn't have been.

"Joan Danner," she said, almost in a whisper. "Yeah, I'm here to ride the bus, as far as First Contact. I hear they got jobs up there. More'n I can say about *this* place."

"First Contact is where I'm headed," I said. I stuck a hand in my pocket, the first I had moved since Joan had come out of the bus. She didn't jump or run. "If you're hungry, the only diner is a few blocks over." I gestured with my other hand. "Emma's Eats."

"I'll wait to eat when the bus leaves. They still serve sandwiches and stuff, don't they?"

"Yes, but the bus might not leave until tomorrow or the next day."

She bit her lip, then shook her head.



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"I'll wait. Got no choice. I got the money for my ticket and not much else. Got to hold me until I find work."

There have been times when I faced choices like that. "You don't sound like you're from around here," I said, changing the subject. She had let on that she had a little money, which meant she wasn't overly afraid I might try to rob her. "More like from up north somewhere."

"Wisconsin," she said. "Haven't been back there in ages. Thought I could find someplace where living was easier."

"That's always something to hope for," I conceded.

"You don't much sound like the people around here either," she said. "I can't place where you might be from though."

"Lived most of my life in Atlanta. Grew up there and in Washington. Moved around quite a bit when I was younger. Guess my accent's a mix of everything."

"You lookin' for work too?"

I shrugged. "What I can find. Only way to make it."

Her face was grim as she nodded. "I wish that clerk would show up so we could find out if this bus might actually leave today," she said, looking around quickly.

"He said he might have to ride up into the mountains to salvage a part from a bus that crashed. To fix this one. Said if he did, it could be a couple of days before we get started." She frowned quickly as I said that and it made me wonder how long it had been since her last meal. "Maybe he left a note on the door on the street side of the depot."

She glanced toward the corner of the building. "Guess it won't hurt to look." She started walking in that direction. I let her get a few steps on, then followed, careful to move more slowly than she did and not get any closer. I still had the feeling she might spook easily.

There was no note on the front door. Joan looked through the glass, putting her hands on either side of her face to get rid of the glare on the window. "Nobody inside I can see," she announced. She turned toward me. "You got any other ideas?" She made that sound like a challenge.

"Not offhand. There was nothing on the door on the other side, either. I looked there before. But if neither the clerk nor the mechanic is here—let alone the driver—I don't think there's much chance that bus is going anywhere today."

She didn't say anything, but I heard her stomach growl. She grimaced, then looked at the ground between us.

"How long has it been since you've had anything to eat?" I asked. I really didn't *want* to—I didn't have enough money to buy meals for every hungry person in town, even the more-or-less attractive female sort—but the words came out anyway.

She hesitated, then shrugged. "Day before yesterday, I guess. Couple of eggs and some soup."

I thought about the money I had—I knew the total to the last penny—and how long it had to last. I closed my eyes for an instant. "Let's go to Emma's," I said. "She must be open by now. I guess I can spring for one extra meal."

For a second, I thought she *was* going to run off. "I don't want no charity," she said. "I made it on my own since I was sixteen. I ain't gonna starve. Gone without food longer than this."

"Look, we get to First Contact, maybe you'll get work before I do. Then you can pay me back. A man died on the bus coming here from Atlanta. I don't want to see anyone else go that way on this trip." I didn't know *why* the old man died, but . . . it served my purpose.

"Well, OK. I *am* hungry. But don't think it buys you anything." She didn't have to spell out what she meant.

We must have been a strange sight—clearly together but never within arm's reach, glancing nervously at one another



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but trying not to get caught looking. Joan was four inches shorter than me, but I doubted that she weighed half what I did—and it's been a long time since I had more than two or three extra ounces of meat on my bones. We didn't talk, so I had time to wonder what her story was. On the road, *everyone* has a story. Some are pathetic, others are just . . . routine. There are just so many ways a person can start drifting—or get set adrift. Even pathos can get monotonous.

When we reached Emma's, I held the door for Joan, and she gave me a look as if I were a derelict out of some forgotten century. Or as if she thought I might do something . . . inappropriate. But she didn't object, or move, when I sat on the stool next to her at the counter.

"Howdy, Woody," Emma said. "I see you found a friend."

"Joan Danner, Emma," I said. "Another passenger waiting for the bus north. We're both hungry." I pulled the buck and a half for two meals out and set it on the counter so Emma would know I wasn't looking for a handout.

"Nice to meet you, Joan Danner. We got fried chicken with biscuits, rice, and peas today—nothing fancy but pretty good if I do say so myself. Can't say the coffee is any better than yesterday, though." She set up coffee cups and poured, then turned to get the meals.

"Smells real good," Joan said, scarcely waiting for Emma to get her hand out of the way before she reached for a chicken leg.

Emma gave me my dinner and smiled. Very softly, she said, "Since you helped with the cleaning-up yesterday, I figure you earned one meal." She took half the money I had laid on the counter and pushed the rest back toward me.

"Thank you," I said. "That wasn't what I was looking for, but I appreciate it."

"By the way, Taylor left a note this morning. Said it looks like the bus will leave today, but maybe not until real late. Left an order for sandwiches and chips. I handle all the food for the bus line here. That's 'bout the only thing that lets me keep this place open."

"If he said how many people, add one," Joan said. "I got the money for my ticket but I ain't bought it yet."

"I always allow fer a couple extra." Emma grinned. "Part of my contract with the bus company. Don't you fret none. There be plenty food to get you to Knoxville. That's the next reg'lar stop. An' if you want seconds now, I got plenty. No extra charge." I looked at my companion. She hadn't left anything but bone on the chicken, and she was still working on the rest of the meal. *Hungry?* I think she was a lot closer to starving than she had let on. But . . . well, I hadn't left much myself, and it had been less than a full day since my last meal.

"Thank you, Ma'am," Joan said and Emma nearly went into a giggling fit.

"Just Emma," she said once she got the giggling under control. "We're all just folks here."

Food seemed to take a lot of the edge from Joan. Her face looked, well, softer. Once she relaxed, she looked much closer to twenty than thirty. I was feeling uncommonly content myself, with a full belly and less worry about when the bus would resume its journey. I had my head turned so I could watch Joan without being too obvious and I started thinking the things a man is apt to think when he's with an attractive woman. But it looked like this wouldn't go beyond thinking. Sometimes it's hard to remember the last time it did.

The three of us talked. Most of the time it wasn't anything special, just conditions—the weather and the way things were—neutral things that didn't force anyone to say anything personal. I don't recall what prompted the remark, but at one point Joan said, "Seems things had to be better at one time, but that must have been before I was born. I wonder if I'll ever see good times."

"When the Good Lord thinks we're ready," Emma said. "Maybe He's teach-



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ing us a lesson for the way we was when things was good before. But it's sure been a hard lesson for a lot of folks."

"I was a kid when the Collapse happened," I said, sort of looking past Emma, if you know what I mean. "After the aliens came, everybody thought things would get better than ever, and I guess things were pretty good then. People went out and bought like there was no tomorrow. Onward and upward. Tomorrow's always going to be better than today. But the aliens were gone and didn't come back, and there was tomorrow, and all those bills due. Folks couldn't pay, so businesses couldn't pay and the banks went under and the government didn't do anything the way they had other times—they argued so damned much at who was to blame that they didn't get anything done until it was too late. Then the oil stopped flowing so freely and things got worse instead of better. Everything sort of snowballed, and by the time Congress was ready to act, they couldn't do much after all."

"Were there really aliens or was that just some fairy tale somebody dreamed up so we'd have somebody to blame?" Joan asked.

I felt my jaw drop, leaving me gaping open-mouthed. She was *serious!* She wasn't certain aliens had come to Earth. I couldn't *believe* anyone might doubt that. "They were real. That was before I was born, but I saw all the video, and my folks told me about it. I *have* seen the robot they left, once, a lot of years ago."

"If *you* didn't see them, how can you be sure?" she asked.

"My folks said it was real. I trust them. And nobody could have faked everything, especially not that robot."

Joan got a deep pout on her face. "We'd have been a lot better off if they'd never come. Or if they had come back to help us."

"Maybe that's the problem," Emma said. "People look for those space folk to bring us a bright new life. They should be waiting for Jesus. I don't care if those space folks never come back, but I do hope to see the day when the Lord does. He promised. The way I heard it, the aliens never said, one way or t'other."

"I was thinking about that myself before," I said. "The aliens never said they were coming back. It's just that the way they left that robot, everybody figured they'd be back and maybe pretty soon. Fancy robot supposed to be better than anything we could make. Nobody could believe they'd just abandon it."

"Maybe something happened to them before they could come back or tell anyone about us," Emma suggested. "Maybe the Lord thinks we're not ready to deal with folks from other worlds until we learn how to deal with the folks we got right here."

"I ought to go to the depot," Joan said, suddenly, as if she had just remembered the bus. "Make sure I can get a ticket."

"There be no problem about that," Emma said. "They got plenty of seats. But, maybe you better go along. Maybe Taylor know when the bus be leaving. Woody, you tell him I'll bring the sandwiches and things over after I close at four. If he needs them sooner, tell him to let me know, but I don't think he will."

"I'll tell him. You know, I'm going to miss you, Emma. You're good people."

She smiled. "I try, Woody. I purely try."

"She's a nice lady," Joan said after we left the diner, "but I was afraid she was gonna start singing hymns."

I shrugged. "I've learned a few of those over the years. I don't know if they do any good, but they can't do any harm. But, yeah, Emma is nice. There aren't enough people like her around, leastways, not that I've come across." Joan and I weren't quite as far apart on the walk back. I could have touched her cheek . . . if I had dared. I wasn't certain I wanted to, though, and I had no reason to suspect that her reaction would



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be anything I wanted to hazard.

Taylor was standing next to the bus when we got to the depot, talking with the mechanic. I had stopped at the motel to get my suitcase and tell the woman in the office that I wouldn't be staying another night. Taylor seemed downright happy to see me. "Got good news, Woody. Fred thinks he'll have the bus ready to go by six or so."

"That is good news," I said. "Taylor, this is Joan Danner. She's looking to buy a ticket north."

"All the way to First Contact," Joan said. "I called last week about the price."

He nodded. "I do recollect that. Only call I've had lately, so it must have been you." He grinned. "Come on in. I'll get your ticket wrote up. Looks like only five passengers; well, five fares and a baby. Had two others cancel."

Five passengers on a bus that had been designed to carry fifty. We'd have all the room we wanted to stretch out and sleep. Of course; heading through the mountains, it was probably a good thing we'd have such a light load. I wasn't certain that antique bus could make the crossing just pulling its own weight.

I went inside with Taylor and Joan, and passed along Emma's message. "Plenty of time for that," Taylor said. "If Fred doesn't need me to help put the bus back together, I'll head on over to Emma's to help carry 'em."

Knoxville is a little west of northwest of Asheville, but our route wouldn't be direct because of the mountains. We would start west, turn north across the mountains, then work west and a little south. When I was a kid, that drive might have taken three hours. These days, I wasn't certain we'd make it in six days, and that's all I had left to get to First Contact by the anniversary of the landing. *If we make Knoxville in three days, I should make it on time, even if I have to walk half the distance between Knoxville and First Contact.*

"You suppose we'll have to push this crate over the mountains?" Joan asked. She had surprised me by taking the seat next to me—across the aisle.

"It wouldn't surprise me," I said. "I just hope we make it to First Contact by the sixteenth."

"Why?"

I told her, which meant talking about myself. Talk used up time and kept me from fretting. Joan listened, but didn't say much until I ran out of steam.

"I can see how that might haunt you," she said. She had turned so she could look at me without twisting her head. "I knew a boy, his birthday was New Year's Day. He thought that meant he was supposed to have some kind of special life." She snorted and looked away. "He died. Seventeen years old. Last thing he said was, 'It wasn't supposed to be like this.'" There was no emotion in her voice, but I thought there had to be more to the story than she was telling.

The trip wasn't as fast as I hoped, but neither was it as slow as I had feared. We had to stop every hour or so—more often and for longer after climbing a steep grade—to let the engine cool off. A couple of times I thought we *might* have to push. By the top of the worst grades, that old bus wasn't doing five miles per hour. Three big trucks passed us during the first six hours of the trek, but no other traffic.

We made a longer stop about midnight. The driver said he needed a few minutes to walk around—to clear his head and uncramp his joints. There wasn't much at the intersection where we pulled off, just an old gas station that had been empty so long there wasn't anything but the shell of the building left.

It was three hours—and thirty miles—later when the driver announced, "There's something going on up ahead. Somebody waving a lantern." He didn't put the brakes on right away. We were climbing a grade and not doing



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ten miles per hour. Once he took his foot off the gas pedal we slowed fast enough.

"Looks like a state trooper," the driver said. "He's waving us off into the rest area. We would have stopped here anyway. Keep your seats until I find out what's going on." He pulled to a stop next to the trooper and opened the window.

"Road's gonna be closed until morning," the trooper said. "Big truck got hit by falling rock, just this side of the tunnel. Won't be able to get a tow truck in before first light. Take an hour or two after that to get the road open."

"Driver OK?"

The trooper shook his head. Our driver got the bus into the rest area. There were two trucks there, dark, but intact, so their drivers must have been close.

"You heard the man, folks," our driver said once he had turned off the engine. "We'll be here for several hours. I don't know if the johns here are open. They were the last time I came through, but that was a month ago."

When I got off the bus, Joan followed. "He sounded like this is routine," she said.

I shrugged. "Probably is. We're lucky it's only going to be a few hours. I read about one time there was a rock slide up by that tunnel the road was closed for six months—and that was before the Collapse. This must have just been one or two big chunks that hit that truck."

We found the restrooms and they were open; there were even lights burning. The men's room smelled pretty rank, but it was usable. After I finished, I waited for Joan, almost as if we were really traveling *together*, not just stuck on the same bus.

"I think I want to walk around a bit before we get back on the bus," she said.

I noted the way she said *we*, but I said, "If I'm in the way, just let me know."

The smile she gave me was almost warm, which is more than I can say for the night air on that mountain. "Kinda nice to have someone I can turn my back on," she said. I wasn't exactly sure what she meant, so I just smiled. I didn't think I was old enough to be considered *safe*, if you know what I mean.

She headed away from the lights, toward the highway. There was a path through the pine trees. The night was extremely chilly, and neither of us were dressed for it, but Joan gave no sign that the cool air bothered her.

"I even slept for a time," she said. She stopped, then turned. There was just enough light that I could see her form against the trees, and a little of her face. "I mean, *really* slept. There's been so many times I was afraid to sleep, even when I was exhausted, afraid someone would . . . get at me while my eyes were closed. When I'm awake, I figure I can take care of myself . . . or run faster than anybody chasing me."

"I try not to scare anyone, even on Halloween," I said. It sounded lame, but I wasn't ready to say anything *serious*. Something had scared her, scarred her, badly.

She moved farther down the slope, out of the rest of the light from the buildings. When she stopped, we were too deep in shadows for me to see anything but the vague outline of her face.

"Most times," she said, "I figure it don't bother me no more, what happened, but . . . sometimes I wake up shaking and sweating like I was having a nightmare, only there wasn't no dream, and I don't even know what woke me. I have trouble trusting folks. Like everybody in the world was out to hurt me, an' I know it ain't that way. Not *everybody*."

"Trust can be hard if you've been burned."

The soft sound I heard *might* have been a chuckle. "I'll live, but sometimes I'm not sure it's worth the bother."

"I guess everyone feels that way sometimes." I wasn't moving at all, and I was



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consciously breathing softly, as if anything I did might spoil the moment—whatever the moment was.

"I like the night, the dark," Joan said. "When nobody can see me, when I can pretend that the world ends a little ways from me and I'm the only one in it."

"It's peaceful at night," I said. "You can't see the dirt, the ruins. Even the smells aren't so bad. It's like it's all brand new and working the way it should."

Joan took a half step closer. "You *know* what I'm talking about." Her tone suggested that that was a revelation for her.

"Some of it, maybe," I said. "You ready to head back to the bus? You must be about freezing."

"The cold is better than the heat. You can go back if you're cold. I want to stand out here a little longer."

"I can stand it if you can," I said, making it a joke.

She turned away and took a couple of steps in the direction of the road. We were both silent for several minutes; the only noises were from insects or small birds. Then Joan started talking again, so softly that I had to strain to hear her.

"It was my momma's boyfriend. Hell, he wasn't but two years older than me, maybe not eighteen. Momma liked 'em young. They'd stick around a night or a week, then grab whatever they could and disappear. This one, he stayed longer than most, drunk all the time. Guess he had to get drunk to make it with my momma. One night he come into my room, worse drunk than ever. Said he was tired of old crow and wanted young chicken. He tried to rape me. If he hadn't been so drunk, he would have, but. . . ."

Joan went silent. I didn't say anything, didn't know *what* to say. I thought she wasn't through, so I waited. It seemed like a long, long time before she started talking again.

"I fought, and I guess he passed out from all the booze before he could get what he wanted. He lay on the floor, pants down around his knees. I went to the kitchen and got a knife and cut his thing off so he couldn't do that to anyone. He screamed and grabbed himself, but he didn't wake up. Too damned drunk. I put together the little stuff I had and left home. Never been back. Never goin' back." She turned to face me again and I could see the glint of a tear on her cheek.

"I don't blame you a bit," I said when I found my voice. It wasn't easy. "The punishment fit the crime."

"I *thought* about cutting his damned throat, but I didn't. Couldn't. But if he died from all his blood pouring out where I did cut him, I wouldn't have fretted for a minute. Don't know if he did die. Don't much care. I didn't cry then and I'm not crying now." She wiped that tear from her face.

"Save your tears for those who deserve them," I said.

"You bet!" She was quiet for a moment before she said, "I guess it's time to go back. It is getting chilly."

We started walking back toward the buildings and the bus, so close to one another that our arms brushed with every step. I was trying to decide whether she was doing that on purpose or if it was just the uneven ground when she suddenly stopped and said, "What's that?"

"What's what?" I asked, stopping and looking past her into the dark. "I didn't hear anything." Then I did, a soft rumbling noise that sounded close.

"That," she said. "Who's there?"

"Maybe a wild animal," I said, whispering. "I don't know what-all they've got up here, maybe even bears."

"Fine time to think about that!" Joan said.

A soft pinkish light came on a couple feet off the ground.

"No bear I," a tinny voice said. That rumbling noise sounded again, only now I could make out that it was gears or wheels. The light got a little brighter.

It was the alien robot.



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Out in the middle of nowhere, in the middle of the night, it couldn't have been any of the inferior imitations humans had built, copying the look of the alien robot but not its capabilities. I didn't think any of those imitations were still working—most were built right after the aliens left, before the Collapse, and few had functioned for long—and if there *had* been one still working, there was no way it would be in the mountains in the middle of the night.

I stared at the robot. A crazy thought went through my head: *Another omen.* The photo of the robot on the wall of my motel room got promoted to omen status as well. *Another reason to get to First Contact before the sixteenth.*

"What are you doing here?" Joan asked, hesitantly reaching out to touch the robot with one finger.

"Studying," the robot said, the word coming out in three distinct, separated syllables—*stud . . . y . . . ing.*

"Studying what?" Joan asked.

"Humans." Again, the syllables were distinct, as if the robot put his words together one sound at a time.

Finally, I thought of something to say. "Are you heading toward First Contact?"

This time, the robot's answer did not come immediately. Thirty seconds must have passed before it spoke. "I will go to First Contact." Something about the phrasing gave me the notion that the robot had just made the decision.

"We're going to First Contact too," I said. I gestured up the slope. "By bus. We can't leave until they clear some wreckage on the road. In the morning. You could ride with us, if you want to. I don't think the driver will try to charge you." I didn't have any idea how the driver might react, but . . . I was ad libbing like mad. Hunch, superstition, whatever. It had suddenly become important to me that the robot ride to First Contact with us. I even found myself wondering how heavy it was, if I could pick it up and put it on the bus if it didn't want to go. The robot took so long to respond that there was time for a lot of crazy notions to zip through my brain.

"The driver will not charge," the robot said. "It is always permitted to ride." It started moving in the direction I had pointed. Joan and I followed.

"What are you doing?" she whispered.

"I don't have any idea," I confessed. "I'm just playing this by ear. Maybe it's not a coincidence."

She didn't have to tell me that I was out of my mind. I realized that. But maybe, *just maybe. . . .*

"Are your masters coming back to Earth?" I asked, raising my voice to make sure the robot heard.

"Yes."

"When?" I asked.

"When it is time for me to report what I have learned."

"Soon?"

"They did not inform me of a schedule."

Our driver had left the door open. The robot seemed to have no difficulty navigating the steps. It tilted forward and pulled itself along on rollers with the aid of tiny mechanical claws; there were two narrow rows of rollers and claws on each of its seven sides—eight sides if you include its bottom. But it had hardly started the ascent before our driver said, "What the hell?" loud enough to wake any passengers who might have dozed.

The robot did not speak until it was standing next to the driver. "I will ride with you to First Contact," it said. "This is permitted."

"We came across the robot off toward the highway," I said. "It said it wants to go to First Contact."

"This is permitted," the robot said again.

Our driver took a deep breath and let it out. "It is," he agreed—reluctantly, I thought. "Company regulations permit the robot to ride so long as we don't have to turn away a paying customer." He sounded as if he were reciting from a



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rule book.

The robot slid in front of the first seat on the right side of the bus—the only place where there was room other than in the aisle. Our driver's face had a look of distaste but he didn't say anything. I went back to where I had been sitting before, got my suitcase, and moved it to the front. I sat in the second seat on the right side, close to the robot. Joan moved as well, across the aisle from me again, but she gave me a strange—puzzled—look. All I could do was shrug my shoulders.

I don't know if anyone on that bus had a peaceful night but the baby and the robot. The baby slept straight through. The robot didn't move or make a sound. I tried to sleep, but couldn't. I had trouble keeping my eyes closed. I kept looking at the robot. Maybe I was afraid it would disappear—or I'd discover I had imagined it. Every time I moved, I think Joan moved. Maybe she was watching me more than she was the robot.

When the Sun rose, it showed that a heavy layer of fog had settled in. I didn't want to leave the bus, but had to use the facilities. Joan got off the bus behind me. We were halfway to the main building before she spoke.

"That robot really took hold of you, didn't it? It's that thing about you being born on the anniversary of the alien landing, isn't it?"

My shiver was purely a result of the weather. With the fog, the morning felt colder than the night. "I can't explain it. Maybe I *am* crazy. Like being afraid I'll wake and find that all this about the robot has been a dream . . . or a hallucination."

"If it is, I'm having the same one," Joan said, "and I don't think I am. Not my style." She chuckled, and turned away so I wouldn't see the look on her face.

"If this was my dream or hallucination, of course you'd say that. Maybe you're not real either. Maybe I'm still in Atlanta, locked up in my room and farther from reality than Earth is from wherever the aliens came from."

"Please, Woody, no more. You're giving me a headache."

I hardly noticed what she said except that it was the first time she had called me by name. That grabbed me hard, and I didn't have an explanation for the instant of vertigo I felt.

It was nearly noon before the state trooper—the same one who had been on duty the night before—told us there was one lane clear on the highway and we could get started.

"OK, folks, you heard him," our driver said. "We leave in fifteen minutes. That'll give everyone time to do what they have to do first."

Joan was the first off the bus. I was OK, but followed without thinking. It was as if it had become a habit, and I didn't get to thinking about *that* until much later.

It was two hours later when we dropped below the fog. Our driver had been extremely cautious, keeping our speed below twenty miles an hour. We were in Tennessee by the time the Sun came into sight, and past the worst of the mountain grades. I had tried talking to the robot, but the driver glared at me over his shoulder so I decided any conversation would have to wait until the bus stopped.

We pulled off at the first interchange after we turned southwest for the final run into Knoxville. There was a gas station open. "We'll take fifteen minutes, folks," the driver announced. "They've got restrooms and snacks. We ought to make Knoxville in another forty-five minutes on the road, if nothing goes wrong." There was always that proviso.

The driver was the first off, and he headed straight for the men's room. I made no move to get up, and neither did Joan. I wanted to talk with the robot



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and this might be my only chance before we reached Knoxville. I couldn't be certain that the robot would make the rest of the trip to First Contact on the bus. Once it was known that he was around and wanted to go there, the local authorities might give him a ride.

"Do you have a name other than 'Robot'?" Joan asked it after the last of the other passengers filed past us. She moved across the aisle and sat next to me, closer to the robot.

"I need no other name," the robot replied.

"How long would it take one of your ships to get from Earth to your world and back?" Joan asked. I guess she had become more interested in it now that she had decided the whole alien thing wasn't just a fairy tale made up to give us a scapegoat for how rotten conditions had become on Earth.

"The light of your Sun that was shining when I arrived on this world will not reach the world where I was made for another 647 of your days," the robot said, and that surprised me. It had not directly answered her question.

"What does that have to do with how long the roundtrip would be?" I asked.

"Ship cannot travel faster than light," the robot said.

"You mean it's going to be at least another fifty-two years before your ship can get back to Earth?"

"I did not say that. I do not know that Ship was returning to the world of our manufacture after it left your world."

"Were there other places it might have gone" I asked.

"Many."

"I'm going to go use the can while I have the chance," Joan said, suddenly getting up. "Maybe the rush will be over now. Don't let the driver leave without me."

I nodded but only glanced at Joan. "You mean the ship might have gone somewhere close and might come back here before returning to your homeworld?" I asked.

"It is possible."

"Is it *likely?*" I asked quickly.

"The term is too vague. I do not have proper references."

We did not get to Knoxville forty-five minutes after we left the gas station. Ten minutes after we got back on the highway, we had a blowout—scattering bits of tread recap over the road and shoulder. The driver called the Knoxville depot, then we waited for a repair truck. It was nearly eight o'clock before the bus reached the station. I wasn't too concerned. First Contact was seventy miles away. I could almost walk there by the sixteenth.

Knoxville was more of a crossroads for the bus company than Asheville. There was east-west and north-south traffic, and it was one of the two nearest main stations to First Contact—the other being Lexington, Kentucky. The depot remained open around the clock, and there was no objection to ticketed passengers waiting as long as necessary.

Joan and I took our share of what was left of Emma's sandwiches and chips. The robot got off with us. It went to the ticket counter and informed the clerk that it would be traveling to First Contact with Joan and me. We showed our tickets and the clerk stamped them.

"You'll be changing buses," the clerk informed us. "If you haven't taken your luggage off, you'd better do that first thing. That bus will be heading back to Asheville in the morning."

"We've got our stuff. When will the bus for First Contact be leaving?"

"Not before 10 A.M. Depends when the bus gets in from Nashville. Last I heard, it's due between one and two o'clock." The clerk looked at the robot, then back at Joan and me. "How come the robot is traveling with you?"

"We found it in the rest area there by the Tennessee-North Carolina line. We told it we were going to First Contact. It said it would go there too." I shrugged. "So here we are."



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"I haven't seen it in six or seven years," the clerk said. "It was going to First Contact then, too."

The Knoxville depot was well maintained and looked almost prosperous. There were even vending machines—sandwiches, chips and other snacks, and soft drinks. There was free coffee—as ersatz as what Emma had—at the ticket counter. Joan and I looked over the selections in the machines but passed on getting anything, though I offered Joan a soft drink. We had sandwiches and chips from the bus, and coffee from the counter. We sat on one of the wooden benches and ate. The robot stood in front of us, not offering conversation but always willing to respond to a question.

We didn't ask many. The robot didn't know when its masters were going to return but assumed they would, eventually. It didn't seem to worry about how long it had been or how much longer it might be. It had never said much about the world where it had been made or the beings who made it.

There were other people in the depot. Besides the clerk and a police officer who wandered in and out, there were a half-dozen passengers waiting for the First Contact bus or the bus to Asheville. After midnight, a middle-aged couple came in and asked about the bus from Nashville; they were supposed to meet someone on it.

It was then that Joan announced that she was sleepy. She curled up on the seat next to me and lay her head on my shoulder. She was asleep before I got over being startled at the unexpected display of trust. I was just nodding off when the bus from Nashville arrived.

The clock behind the ticket counter said it was 2:45. The couple who had been waiting walked to the door. Ten people filed in. There were only two children, both with adults. It was one of the family groups, two adults and one girl about seven years old, who recognized the waiting couple. The rest of the passengers went to the ticket counter. Apparently all were going on except for one man who asked the clerk something, then went to the street door and left the station carrying a small suitcase.

It was thirty minutes before the terminal quieted down. Joan went back to sleep, her head on my shoulder again. This time, I managed to get a couple of hours of sleep myself.

It was after dawn when I woke, surprised to discover how close Joan and I had gotten in our sleep. Her forehead was against my cheek; I had an arm around her shoulders, and the contact ran along our sides to her knees. Despite the aches I felt from sleeping on that wooden bench, I felt uncommonly content with the intimacy. *I could get used to this,* I thought, and that startled me. It had been a long time since I had considered anything like that. It's always been more than enough trouble to keep one person going.

Joan woke a few minutes later, and seemed in no hurry to disengage. Then she straightened up, smiled, and went through a routine of stretching and yawning. "I haven't slept that well in ages," she said. She stood and did some more stretching—which showed just how thin she was under the baggy clothes.

"I slept pretty well myself, considering," I said. My right arm, the one that had been around her, had gone numb, and tingled madly as it came back to life. I looked at the robot, standing where it had all night. "Do you ever sleep, Robot?" I asked. "Sleep, or turn off to recharge your batteries, or whatever?"

"Sleep is for organic creatures," the robot said. "My sensory input and evaluation circuits always remain active."

"No way to get away from it all?" Joan asked.

"My function is to observe and record, not to escape."

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The bus left at ten o'clock. There were more than a dozen other passengers going to First Contact. Joan and I sat just behind the robot at the front of the bus. This driver didn't seem bothered by the robot. He even said, "Hello," to it.

Also surprising was the fact that this bus wasn't nearly as decrepit as the other. The engine seemed to have some life left, and once we got on the Interstate, the driver even pushed the bus to thirty miles per hour.

"We have one scheduled stop before First Contact," the driver announced. "We stop at Caryville to see if the Cumberland Gap tunnel into First Contact is open. It was as of nine o'clock this morning, but you never know. If they have a rock slide or a power failure that kills the fans, the tunnel can close any time. If it's closed, we have to go north on the Interstate and around the long way to First Contact."

"Don't you have a mobile telephone to call without stopping?" Joan asked.

"I know it's silly, Miss," the driver said, glancing over his shoulder. "But regulations say that the mobile phones are only for emergencies, and the call to the tunnel authority is routine, so we have to stop."

"It doesn't matter," I whispered to Joan. "We'll be there today, three days before the anniversary."

Joan shrugged. "When we get there isn't as important to me," she said, giving me a weak smile. "I'm looking for work, not . . . whatever you're looking for." She put her hand on mine to take any sting out of her words. I think I managed to return her smile.

*Whatever it is,* I thought. What *was* I looking for? The return of the aliens? Some bizarre personal salvation? Or just something to hang my sanity—or the lack thereof—on? *Will I know if I find it?* I wondered. I guess I never really understood what drove me. Sure, there was that thing about being born on the anniversary of the alien landing, but was that so important? It had to be coincidence. I knew that, intellectually. Hundreds of thousands of people had been born on anniversaries of Landing Day—thousands on the very day the aliens landed. *Those folks will all turn fifty this week.*

"In some ways, I'm going to be sorry that this trip is over so fast," I said—not aware I was speaking out loud until Joan turned to stare. "It's been nice to have you to talk to."

I could feel my face getting red as Joan's openmouthed stare turned into a smile. "I guess it's been pretty nice having you around too," she said. "Reminds me that not everyone in this world is an SOB."

"Thanks, I think," I said. We both laughed, then looked away from each other. But she took my hand, gave it a squeeze, and continued to hold it until we stopped at the Caryville exit. We got off the bus to stretch our legs and do the necessary, then got sandwiches from the stock on the bus to eat during the next part of the ride.

After the driver confirmed that the tunnel was open, we headed northeast along the two-lane highway that paralleled Cumberland Mountain. We turned north at Harrogate—saved from becoming a ghost town when the private university there folded by the presence of First Contact on the other side of the mountain—and went through the tunnel under Cumberland Gap into Kentucky.

And the town of First Contact. Before the coming of the aliens, the town had been Middlesboro. Nestled in a valley with high ground all around it, the town had never been particularly large or prosperous. Before the aliens, its major claim to fame had been a restored fighter plane of World War II vintage—a plane that had been "rescued" from under the ice cap on Greenland forty-odd years after the war. That plane was in a museum at what had been the town's airport when there were still private planes flying.



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Coming out of the tunnel, Highway 25E became Contact Parkway, and the billboards fanned out on both sides of the road, touting accommodations and attractions. On the right, past the first intersection, you could see where huge sections of mountain had been dug away to give the town more room. That had started before the arrival of the alien ship and stopped only after the Collapse. The bus station was on the left, two blocks inside the start of the town itself.

There were two motels just south of the station, and a livery stable on the north—a place with horse-drawn cabs and buggies to rent by the hour or day. Even First Contact did not boast more than a handful of automobiles, and they belonged to the town's most prosperous residents.

Joan and I each grabbed a final couple of sandwiches from the bus—that much longer before we would have to worry about buying a meal. We got off the bus with the robot and went into the station, which turned out to be the perfect place to look for employment opportunities and cheap accommodations. In one back corner, between the doors to the public restrooms, there was a bulletin board with handwritten ads—jobs wanted, jobs available, rooming houses, and so forth.

"If these are up-to-date, we shouldn't have much trouble finding work," I said after scanning the board.

"Four places that want waitresses," Joan said. It was the first mention she had made about what sort of work she had hoped to find. "There aren't that many openings in a year back home. Maybe here people still tip waitresses."

There were a few job openings I thought I could handle without difficulty and a couple others I would attempt if necessary—I've never been too picky about what I would do to earn food and a place to sleep. "I'm going to take a few minutes to get cleaned up, then start answering ads," I told Joan. "I imagine I can check my suitcase here while I do that."

"I need to clean up too." She looked down at herself. "Wish I had a change of clothes, but these will have to do."

"You look fine," I told her.

She started to smile, but that was quickly replaced by a nervous look. "If you want, we could meet here after we make the rounds for jobs. I was thinking . . . ." She stopped, as if she weren't certain she wanted to share her thoughts. "We could save some money if we shared a room," she said, *very* hesitantly. "At least until we know what we've got to look forward to. I've kinda gotten used to having you around," she added.

"Yeah, like an old comfortable shoe. I've kinda gotten used to you too," I said. "I think I'd like that just fine."

Joan threw her arms around me and gave me a quick hug. Before I could react, though, she had broken away and went into the ladies' room. I shook my head and went into the men's room, wondering what I was getting into. The robot didn't say anything. It just stood there. When I came out of the restroom, the robot followed me out of the bus station—after Joan and I had wished each other luck.

We had arrived in First Contact a little before three in the afternoon. By six o'clock, I had a job and had worked two hours, at a little more than the going rate. I had the robot to thank for that. It had tagged along and the manager of the first place I applied for work hired me on the spot—to sell souvenirs, many of which featured pictures of the robot, as well as soft drinks and snacks. Ted Arney, the manager, also gave me a note to give to the woman who ran a boarding house two blocks away. "She'll give you a special rate, since you're working here," Arney told me. He also paid me, in cash, for those two hours. There was a lot of transient labor in First Contact. Nearly everyone paid daily, at the end of each shift.



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Six o'clock was the time Joan and I had arranged to meet. She was pacing in front of the depot as I walked down Contact Parkway, and from her smile I was pretty certain she had a job.

"I start tomorrow morning," she said. "The manager loaned me money to buy clothes." She pointed at a bag on the bench behind her. "Already bought them."

"That's great." I gave her my news, and showed her the note. We went inside the station to retrieve my suitcase, then headed for the rooming house—with plans to go out and eat once we had our living arrangements settled.

I've never been the domestic sort. Most of my adult life I've lived alone, with only occasional, temporary, companionship. I had no reason to think this relationship would be permanent. It was a convenience, for both of us, a way to save money and have someone to talk to. We didn't have our first kiss until we were in our room, and that came as a surprise to me. Joan stretched up on her toes, gave me a quick kiss on the mouth, then backed away before I could get into the spirit.

She went down the hall to take a quick shower, put on her new clothes, and wash the ones she had been wearing. Then I hurried to wash up and change so we could go out to eat before it got too late. I decided that I would save my laundry for later.

The restaurant where Joan was going to work had closed, so we walked along the Parkway until we found a place that was open. Joan seemed almost bubbly through dinner and the walk afterward. We took the long way. Joan had never seen First Contact, so she wanted to look around. We drew stares, but I did not flatter myself that they were because we made such a stunning couple. The robot was with us. We talked with it occasionally—mostly Joan asking questions and the robot's brief replies.

I was starting to wonder what we were going to do with the robot when we went to bed. I wasn't certain that Joan and I would do anything but sleep—some of my temporary relationships *had* been merely for the convenience of two people having a place to sleep—but if we did, I didn't want our every move and word recorded for the eventual instruction and amusement of the robot's alien masters. Some things shouldn't have an audience . . . especially not on opening night.

It was near ten o'clock when we got back to the boarding house. At the door to our room Joan turned to the robot. "Woody and I are going to bed now," she said. "We need privacy. Tomorrow we both work, and we'll be happy to have you around then, or you can do whatever you want to do."

"Yes," the robot said. "I will observe others. I will see how this place has changed since the last time I observed here." It didn't have to turn. It had no real back, front, or sides. Any direction was fine. The robot simply started moving toward the front of the boarding house.

"I was wondering about that," I said as I followed Joan into our room. "That robot would have made me more nervous than I am already."

Joan waited until I had closed the door, then she came into my arms and we shared our first *mutual* kiss—lingering, affectionate, tender, but not especially passionate. "No promises, no strings," she said.

"No strings, no promises," I said. Yes, I had heard that line before—and spoken it.

There was more tenderness than passion when we made love. Slow, the way it should be, but often isn't—maybe the lack of wild emotion helped. Later, after I thought Joan was asleep, I heard her sobbing softly, lying with her back to me. I turned her around and held her. She wouldn't say what was bothering her, claimed that nothing was wrong.

The night of May 12th, the morning



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of the 13th—three days until the anniversary of the alien landing.

May 13th through 15th: three days were long enough for us to slip into the routine of a new life. It's easy once you've done it often enough. Joan and I worked eight to ten hours a day. When we could, we met for lunch, ate supper together each evening, and did a little sightseeing. The robot came and went, traveling around First Contact doing . . . whatever, but it visited each of us at work once or twice a day, and each evening it followed us while we wandered. When we went to the boarding house, the robot went off on its own.

The robot gave us a certain notoriety. People noticed that it kept returning to Joan and me. People knew who we were, and wanted to know more about us. Joan was certain that half her tips were because of the robot.

Joan and I both started thinking of the room we shared as a refuge, the one place we could escape the questions and stares the robot drew to us; maybe we clung to each other more than we would have otherwise. I wasn't certain how I felt about Joan, but—subconsciously—I started to sense that she was more than a chance encounter to be forgotten as soon as we parted.

The robot might have made life easier for us, but it made me nervous having people turn to stare and asking questions as if I were the world's leading living expert on the robot and the aliens. It fed my own obsession with them, and with the approaching anniversary of the alien landing . . . and my birth.

The night of the 15th, I hardly slept. I was too nervous. I might have been six years old and waiting anxiously for Santa Claus on Christmas Eve . . . before the Collapse made Christmas just another day of disappointment and pain. Joan seemed to understand what I was going through, and tried to hide the amusement she obviously felt at my rabid anticipation—and the edge of fear. She tried for more than an hour to calm me, then gave up and went to sleep while I stood by the window and looked out at the night.

Anticipation *and* fear. I had a growing—and illogical—notion that this was the anniversary the aliens would return for, that something would happen to make sense of the coincidence of my birth on the fifth anniversary. I didn't know what, exactly, that might be, or how it could bring me any sense of . . . I don't know, completion, I guess. But behind that anticipation was fear, stronger as the night progressed: How would I respond if I were disappointed again, if they didn't come? And *that*, the morbidly sane remnant of my mind kept reminding me, was infinitely more likely. They hadn't returned in fifty years, why now? And why should fifty of *our* years mean anything to *them?*

*Wouldn't we know already if they were close enough to get here for the anniversary?* I asked myself. There were telescopes, radars, radios—all looking for any hint of the aliens' return. Second visit, Second Coming. I guess that was the way I was thinking. Maybe I was confusing the two; maybe I always had. I've never been particularly religious, but I haven't stood completely apart either. My parents sent me to Sunday School when I was little, took me with them to church before everything fell apart. And I had gone to church now and then as an adult.

I did *try* to sleep. I climbed into bed, closed my eyes, took slow, deep breaths, and lay waiting for oblivion to come, but it didn't, and after a time I got out of bed so I wouldn't wake Joan with my feverish tossing.

*They didn't call ahead the first time, and no one spotted them until twenty minutes before they landed,* I reminded myself. Maybe no one was still looking. Governments and universities had felt the effects of the Collapse. Maybe I was the only person who felt such an imme-



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diate anticipation.

In the last hour before dawn, I guess I did doze, but as soon as Joan started moving, I was awake again, and then it was too late for sleep. May 16th, the fiftieth anniversary of the landing, my forty-fifth birthday. My brain felt like mush. My eyes felt as if someone had poured glue over them.

"Are you OK?" Joan asked when she was ready to leave. "You look terrible."

"I'll be OK once today is over," I said. "Once this waiting is over, one way or the other, I'll get back to normal." *Whatever* that *is,* I thought. "If there's anything wrong with me, it's just that I can't get my head straight."

"See you at lunch?" Joan asked before giving me a quick kiss. Another domestic touch, hello and goodbye kisses, so fast they were almost imaginary. What was scary was how easily we were falling into the routine.

"If they haven't locked me in a rubber room before then." I tried to put a smile around those words but, judging from the look on Joan's face, I didn't succeed. I put my hands on her shoulders. "I'll survive. There's nothing *physically* wrong with me. It's just . . . well, you know."

"I know." She gave me another quick kiss and was out the door, worried that she might be late to work.

*We've got to get a clock, or a watch,* I thought. The problem of keeping time distracted me for a few seconds—trying to figure out if we had enough extra money to spend a buck for an alarm clock. But distractions worked only so long. I opened the window and stuck my head out to look around. *Maybe the aliens landed during the night,* I thought. *I don't know if we would hear them, and I can't know that anyone would wake us.* Crazy thoughts. A crazy time. For me.

After a moment I took a deep breath of the chill morning air, then pulled my head back inside and closed the window. I could only find out if anything had happened by going out . . . but if I went out, I might learn that nothing had happened, and all of my anticipation had been wasted. This. That. Six other things. Variations on the theme of self-torture.

I had to force myself to wash, shave, and dress. It was slow, with frequent interruptions—minutes spent staring into nothing. I started telling myself that I was going to be late for work, but it was difficult to force myself to step outside to find out what the day had to offer—most likely a cosmic sneer, or a horse-laugh at my hopes.

When I did leave, there were no bells, fireworks, or horns—nothing to give any indication that anything out of the ordinary was happening in First Contact. *Nothing says they have to land the same place they did before,* I thought. *They might land anywhere.*

Then I noticed the robot standing off to the side, waiting for me. "Have your masters returned?" I asked.

"I do not know," it said. "They have not contacted me."

I started walking. The robot tagged along. "How far away could they contact you from?" I asked.

"Distance is not the key element. Time is," it said.

"What's that supposed to mean?"

"Ship can generate sufficient signal strength to reach my receiver at any likely distance, and can focus the signal so that I would hear it. I say that time is the key element because for every light-minute away Ship is, that is one minute between the time of transmission and the time of reception: If Ship is ten light-years away when it sends a message, I do not receive it until ten years have elapsed."

I stopped walking, just for an instant. "*Has* Ship sent you messages since it left here?"

"Only once, mere days of your time after Ship left."

I wasn't the only person who had



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come to First Contact to observe the anniversary, though I might have been the only one *obsessed* by it. Arney told me that even during the worst years of the Collapse, First Contact always had several thousand more visitors than the daily average on Landing Day. The numbers start to build a week before and tapered off gradually afterward. This year the projection was for ten thousand visitors in town for the day. There were even news teams in to give the anniversary some coverage.

No reporters dropped by to talk to me. I was surprised by that—maybe even disappointed. Certainly *someone* must have mentioned to them that the alien robot had been hanging around with two individuals. Maybe the reporters knew what they wanted to show before they arrived.

Though there were no massive throngs, the souvenir shop was moderately busy. Occasionally it got stuffy with too many bodies in too small an area. There was enough business to keep my mind off what day it was and the fact that there had been no news flash that the aliens had returned. The robot didn't stick around, and by the time Arney told me to go to lunch, half an hour later than usual, the robot hadn't come back.

I walked to the diner, half-expecting to learn that Joan had already taken her lunch. I looked at all the people walking from museum to souvenir shop, and down the road to the landing site—in what had been the parking lot of a large chain discount store. Joan hadn't eaten, but I discovered that I had no appetite, so I drank a cola while she ate, and left long before I needed to. "I want to walk up to the landing site," I told Joan. She said she understood and that she'd see me after work. We didn't kiss goodbye in public.

I had been to the landing site three times since arriving in First Contact. The only physical evidence left after fifty years was the circle of scorched pavement and potholes where the ship's four landing supports had settled through that pavement. Four more-or-less round holes, identifiable as the points of contact only because of the signs and photographs. The scorched and partially crushed remains of one automobile that had been in the way were in the museum—in what had been the discount store.

There were about a hundred people looking past the guide ropes at the holes and the scorch marks that had faded considerably. Several men were hawking souvenirs. Two police officers were standing around, ready to maintain order, or to collar anyone attempting to pick a pocket or sell tickets on the next flight of the alien spacecraft. But people weren't gawking into the sky. No alien ship was making its descent.

I worked my way through the crowd to the ropes that cordoned off the actual landing site and looked with the rest of the people at the only physical evidence of that landing. Stood. Looked. Listened to the chatter of visitors discussing the site and the landing, excited or disappointed, speculating on what had happened and what might happen.

I don't know what the catalyst was, why it happened just then, but it suddenly hit me, with more force than a punch to the jaw, the realization that the aliens were not coming back—not that day, and probably not soon. It was a physical feeling that washed over me from the roots of my hair through my face and neck and down my body, a flow of despair and . . . loss. Blood flowed downward, out of my head. I got dizzy. My eyes weren't working right and I wondered if I was on the verge of fainting.

Someone else must have wondered too. I felt a hand on my arm and a concerned, "Are you all right?" I had difficulty focusing—the voice seemed to come from miles away—and an extended time seemed to pass before I could turn my head to see who was talking. It was one of the police officers.



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"I think so," I said. "I just got dizzy." I sucked in as deep a breath as I could manage and let it out—only then realizing that I was holding the rope with both hands. I had difficulty getting my hands to obey the mental command to let go. "I'll be OK. Thanks for asking." I turned and met the policeman's gaze. "I'll be OK," I repeated while I worked my fingers, trying to get the stiffness out. Who was I trying to convince, him or me? I wasn't certain.

"Maybe you'd better sit down for a minute," he said. "There are benches over here. I can help you."

"No, really, officer, I'll be OK. I feel better already. Besides, I've got to get back to work. I'm on my lunch break."

The cop blinked, almost in slow motion. "You're the new fella working for Ted Arney, aren't you? The guy the robot hangs around with."

"Woody Clayton," I said. "Yes, I work for Ted Arney, and he's expecting me back so he can eat *his* lunch."

"Have you eaten? Maybe that's your problem."

"Maybe. I *did* skip lunch," I admitted. "Wasn't hungry."

"Not good to skip meals if you don't have to," he said, a tactful way of putting it.

"Thanks. I'll be OK." I was getting tired of saying that. "I really do have to get going."

"If you're sure you can make it. . . ."

I headed toward the shop, but stopped and ducked between two buildings—out of sight of anyone—before I got there. I put my hands against a wall and leaned forward. Tears came, and great, heaving sobs. For a moment, I wasn't sure I would be able to stay on my feet, even the way I was supporting myself. My knees were trembling, as if they were about to fold.

The aliens hadn't come, weren't coming, not then, not soon. I had become so wrapped up in certainty that they *would*. Disappointment doesn't cover what I felt. Disillusionment isn't even strong enough. It was as if my entire life had crumbled, leaving only a shell—with everything inside pouring out in tears. I have no idea how long I needed to get myself under control. I straightened up, wiped the tears away, and took several deep breaths. I still had the rest of the day to get through. And the rest of my life.

"Sorry I'm late, Arney," I said when I got to the shop. "I walked up to the landing site and got . . . a bit dizzy. I'm OK now," I added before he could ask. "Just something came over me for a minute." Since the cop had recognized me, there was a good chance he would say something to Arney—sooner or later.

Arney looked me over. He eyes narrowed—maybe it was clear I had been crying—but he nodded. "No harm done. As long as you're sure you're OK, I'll go get my lunch." He grinned. "Business has been good today—all week. Every time your robot stops by, it's sure to have customers tagging behind. It just left, ten minutes ago." He came out from behind the counter. "By the way, Gwen Twilling from the Visitor's Bureau said she'd stop by this afternoon to talk with you and take a few pictures, unless you'd rather not."

I didn't have to ask why the Visitor's Bureau wanted an interview and photos. "It's OK by me," I said. "I've got nothing to hide." No more than anyone does. There were no police or lawyers looking for me—that I knew of.

It was near the end of my shift before Gwen Twilling arrived. We talked. There was still an empty hole in me, something that made me feel detached, so I was able to get through it without difficulty. The aliens weren't coming to mark the anniversary and nothing else much mattered.

Gwen was old enough to have been around when the aliens landed—six years old at the time, she said—and I asked her as many questions as she asked me. She remembered the landing,



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as well as anyone who had been six years old might have, and she recalled seeing the robot when it first came off the ship.

Gwen and I had been talking for about twenty minutes—and collecting spectators—when the robot wheeled into the shop. There were eight or nine people following it, so the store was suddenly crowded. Gwen snapped a couple of pictures with the robot standing next to me—I was sitting, so it didn't take much to get us both in frame.

"Why have you come back to First Contact just now?" Gwen asked the robot once she had her photos. "I know you come now and then, but is there any particular reason why you came back when you did?"

"I had no reason not to come," the robot said. "I was observing. I met Woody Clayton and Joan Danner. They were coming here. Woody asked if I were coming here. I said I would come." The robot's slow way of speaking, separating syllables, seemed to grate on Gwen. I had gotten to the point where I normally didn't notice the halting speech pattern.

"Do you expect your masters to return soon?" Gwen asked.

"I expect them to return. I have no knowledge when," the robot replied.

"It has been fifty years," Gwen said. "Did you expect it to take this long for them to return to pick you up?"

"I had no information on which to base an expectation."

"Will they come back to First Contact when they return?"

"I have no knowledge of their itinerary."

The interview went on like that. After the robot arrived, I sort of faded out of the picture—which was fine with me. Gwen Twilling was never at a loss for a question, and if the robot's uninformative answers frustrated her—as they clearly frustrated some of the spectators—she did not show it. She tried asking the same question in different ways, trying to draw more information from the robot—without success.

I think Arney was getting impatient. His store was crowded, but he wasn't doing much business. The people were watching, not shopping. But he stayed quiet, hovering near his cash register to ring up the occasional sale. While Gwen and the robot sparred, about all Arney sold were soft drinks. When Gwen finally stood, thanked the robot and me for our time, and said that she had to go, there was visible relief on Arney's face. He spoke up to hawk his wares for those who had been listening to the interview, and people did look around once it was clear that they weren't going to hear any earthshattering revelations.

It was past my quitting time, but I hung around to help Arney through the slight rush of business after Gwen Twilling left. The robot remained, but just stood where it was, not saying anything.

It was ten minutes or so after Gwen left before I noticed Joan standing by the door, and I wondered how long she had been there. I smiled and waved. She raised her hands and clapped silently, to let me know she had seen some of the interview. A few minutes later, Arney told me I could leave and gave me my wages. "We ended up doing pretty good today," Arney said after he counted out two extra dollars. "You're good for business."

He said hello to Joan, who had come over to us, and then we left. Joan linked her arm through mine. I found myself thinking that it was a . . . possessive touch, but it felt good, reassuring, and I needed reassurance very badly. We walked along the Parkway. The breeze felt wonderfully refreshing.

"The aliens haven't come back," I said. "They're probably not going to come back anytime soon."

"Someday," Joan said.

I told her about what had happened to me that afternoon. She held my arm. "Maybe I'm cured," I said. "Or maybe my craziness is just in—what's the



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word?—remission. It might come back in five years, or ten, unless the aliens return first."

"So what now?" she asked.

I stopped and turned to look directly at her. There was concern in her voice, and on her face. *What now? What happens to us?* I could recognize that between the words she had actually spoken. It didn't take a genius.

"I haven't had time to think past *now*," I said. "*Now* is good, better than it's been . . . in longer than I can remember." She smiled and I felt a warm surge somewhere around my heart, where there had only been gaping emptiness before. "Let's get supper from the hot dog stand up the street. We can walk over to the landing site to eat."

"Sure, that sounds fine," Joan said. She took my arm again and we walked. She was closer than before, and I had never been more aware of her presence.

We got our food, went to the landing site, and ate, sitting on one of the benches, behind the constantly-changing crowd of spectators, not paying much attention to them or to the patch of parking lot that had changed life on Earth forever. Sunset came and the lights went on around the landing site, leaving us at the edge, partially in shadow.

"You know, things *are* better than they were ten years ago," I said. We had finished our food. I had an arm around Joan and her head was on my shoulder. "And a *lot* better than they were twenty years ago."

"I don't remember twenty years back," she said. "I was just a little kid. I try not to think back even ten years. It hurts too much."

"Things are getting better, and they'll keep getting better, whether the aliens show up next week or not for another hundred years. I think I'll stick around First Contact," I said.

"Me too. I like being able to eat every day. And I like the people here."

We smiled at each other—one of those shared looks that say more than words. Strange. We had known each other less than a week—but I felt as if she had always been part of my life.

"When I get my annuity check the end of next month, we'll have enough extra money that we could get an apartment, have a little more room. What do you think?"

She stretched to give me a soft kiss. "I think we should go down to the grocery store and see if we can find a cake and some candles. This *is* your birthday."

No firecrackers, no fanfare—just a store-bought birthday cake with a dozen tiny candles. I wouldn't have traded it for fleets of alien ships.■

**EDITORIAL** CONTINUED FROM PAGE 6

last forever, either. More gold rushes, similar in some ways and different in ways none of us have imagined, can be expected in the future. And that's not a bad thing, either.

In the meantime, let's not forget that there's another side to that gold-rush analogy. The original gold rush slowed down when the easy pickings were exhausted and what was left required hard work. But the "hard" gold could still be rewarding for those able and willing to do that work. I see analogs to both aspects of that phenomenon in our present situation. The easy pickings aren't what they used to be; people in general are no longer as willing to accept uncritically the idea that they need to be constantly upgrading, just for the sake of having the Latest and Greatest, whether they need it or not. But there are still fortunes to be made for those willing and able to dig for the hard-to-get, buried gold—those who can develop innovations that are not just more of the same, but genuine advances that will seem worthwhile even to critical, demanding buyers.■



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**First Landing**, Robert Zubrin, Ace, $21.95, 262 pp. (ISBN: 0-441-00859-3).

**Mars: The Lure of the Red Planet**, William Sheehan and Stephen James O'Meara, Prometheus, $27, 406 pp. (ISBN: 1-57392-900-X).

**The Complete War of the Worlds: Mars' Invasion of Earth from H. G. Wells to Orson Welles**, Brian Holmsten and Alex Lubertozzi, eds., Sourcebooks, $39.95, 202 + ix pp. (ISBN: 1-57071-714-1).

**Failure Is Not an Option: Mission Control from Mercury to Apollo 13 and Beyond**, Gene Kranz, Berkley, $14, 415 pp. (ISBN: 0-425-17987-7).

**The Chronoliths**, Robert Charles Wilson, TOR, $22.95, 301 pp. (ISBN: 0-312-87384-0).

**The Pickup Artist**, Terry Bisson, TOR, $22.95, 240 pp. (ISBN: 0-312-87403-0).

**Bouncing off the Moon**, David Gerrold, TOR, $22.95, 319 pp. (ISBN: 0-312-87841-9).

**Second Chances**, Susan Shwartz, TOR, $14.95, 382 pp. (ISBN: 0-312-87342-5).

**Changeling**, Sharon Lee and Steve Miller, Embiid Publishing (http://www.embiid.net), $2.99, Embiid ed. (ISBN: 1-58787-090-8), Rocket ed. (ISBN: 1-58787-091-6).

**Hey, It Could Happen!**, Mark L. Ford, Vantage, $19.95, 336 pp. (ISBN: 0-533-12940-0).

Robert Zubrin has been pushing manned missions to Mars for some years now. After years as a senior engineer at Lockheed Martin Astronautics, he became executive chairman of the National Space Society and founded Pioneer Astronautics in Lakewood, Colorado. He is the coauthor with Richard Wagner of *The Case for Mars: The Plan to Settle the Red Planet and Why We Must* (The Free Press, 1996) and with Stan Schmidt he coedited *Islands in the Sky: Bold New Ideas for Colonizing Space* (Wiley, 1996). He has pushed the "Mars Direct" scheme, which involves sending supplies and equipment ahead so that astronauts need not carry everything with them.

If he doesn't really seem to have moved us any closer to our vision of the Red Planet, he remains an ambitious dreamer. And now he has turned novelist with **First Landing**, a tale that begins with impossible heroics and ends on the warmest and fuzziest of notes.

His astronauts are caricatures: "Right Stuff" mission commander Colonel Andrew Townsend, chief engineer and fundamentalist tomboy Gwen Llewellyn, Texas geologist Luke Johnson, Ivy League prima donna Rebecca Sherman, and historian Kevin McGee. Their ship, the *Beagle*, is tethered to a counterweight so it can rotate for centrifugal g's; as they approach Mars, explosive bolts are supposed to cut the tether. When they fail, Gwen's the one who goes outside and then loses her grip on the ship. Townsend jigs the ship to get her back aboard, and when that puts them off track for entry, he does some hot flying to bring them in safe and



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close by the return vehicle.

Why did the bolts fail? For the same reason that, later, the return vehicle dumps its fuel, its computer's CPU is fried, and the crew's air goes bad. There are political battles on Earth. There is sabotage. And as soon as the crew finds signs of life, the pseudo-intellectuals are screaming that Martian life cannot be allowed to reach Earth. "Keep Earth Green, Keep Mars Red," they shout as they burn NASA's buildings. "Don't let the crew come home!"

But where there's a will . . . Zubrin's intrepid heroes find water to electrolyze for fuel. They find another CPU at the end of a daring trek. They fix the air just in time.

And when Gwen gets pregnant . . . You may make a disgusted face—why didn't NASA put these kids on the Pill?—but you can see the warm fuzzies coming. Being a Bible-nut, she cannot countenance abortion even though the regulations insist. And since the baby can't possibly survive the trip back to Earth, or if it did, its low-gravity origin would surely warp it, we get the very first Mars colonists.

I'm sure the "willing suspension of disbelief" so essential to the success of any science fiction story comes easier in this case to those who are enchanted by the thought of Mars. There are a great many such readers—Mars novels are as perennial as those centered on galactic empires or time travel, and they have been for quite a while.

William Sheehan and Stephen James O'Meara go to great lengths to document our obsession with Mars in **Mars: The Lure of the Red Planet**. They devote some 30 pages to the Mars of classic fiction—Wells, Welles, Burroughs, and Bradbury—but spend most of their energy on history and science. Huygens, Cassini, Herschel, Schiaparelli, and Lowell (among others) get their turns upon the stage. So do Mariner and Viking, visions of water and life, times of excitement and optimism about what we might find if we could only visit, and finally a rather glum statement that the "fondest hopes of life beyond Earth" have so far been dashed and "We seem to be stricken once more with a bad case of cosmic loneliness." Yet . . . Mars has a way of renewing those hopes. Sheehan and O'Meara reassure us that it may do so again. All we need is data or theory or perhaps a band of intrepid adventurers to establish a toehold on the world of wonder.

If you would prefer a book that puts more attention on the classic fiction, take a look at **The Complete War of the Worlds: Mars' Invasion of Earth from H. G. Wells to Orson Welles**. It has a foreword by Ray Bradbury and an afterword by Ben Bova. It reprints Orson Welles's famous Halloween 1938 "War of the Worlds" broadcast, with material on Welles and the Mercury Theatre, which adapted many literary works to radio. It tells us of the 1968 replay (which also alarmed people!), the musical, the TV show, the film, the bubble gum cards, and a parody. There's even a brief nod to the science.

And since Welles was, after all, adapting an existing tale, there is a discussion of H. G. Wells and a reprint of his original 1897 *War of the Worlds*.

If that's not enough, an accompanying CD plays the 1938 broadcast for you, along with an excerpt from the 1968 version and a Welles press conference (1938), a joint Welles-Wells interview (1940), and a Welles reminiscence interview (1978).

It's a complete package, very nicely illustrated and assembled, and well worth its price.

Zubrin's characters are good examples of the way we like to think of astronauts and other heroes: As fast as problems arise, they find solutions. They not only survive—they win!

Yet in the space program, it has never been only the astronauts who had that attitude. Gene Kranz, a former Apollo



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flight director whose NASA career began in the days of the very first manned orbital flights, in the cramped Mercury capsules, tells us in **Failure Is Not an Option: Mission Control from Mercury to Apollo 13 and Beyond** that the folks in Mission Control struggled as mightily as any astronauts to solve problems such as those that threatened to doom the Apollo 13 flight to the Moon.

Kranz was there. His anecdotal memoir helps us to join him on the scene and brings what is now history alive. He also affirms that the dream of Mars remains dear to the hearts of those who built the space program.

In addition, he makes it difficult to believe in the sabotage that made Zubrin's fictional Mars mission such a challenge. The folks in Mission Control are far too dedicated to fall so far.

Or so one hopes.

Robert Charles Wilson is as interesting as ever in his latest, **The Chronoliths**. The tale begins on the beach in Thailand, where Scott Warden is an expatriate with a wife, a child, and far too much willingness to goof off. When his drug dealer buddy Hitch Paley shows up with a rumor of strange doings in the hinterlands, they are off to see a mysterious and massive pillar that has appeared in the jungle, sheathed in ice and inscribed with the announcement of a conqueror Kuin's military victory some twenty years hence.

While he is gone, his daughter develops a raging ear infection. His wife flees the country, and soon Warden is back in the States, discovering divorce, and looking for a job. Meanwhile, Kuin is pitching more monuments or Chronoliths into the present, some of them into the hearts of cities, and the world is being swept by chaos. Warden is soon drafted by a former professor—Sulamith Chopra—into the effort to figure out how the heck anyone can pull Kuin's transtemporal tricks. Sue has the theory, though—it's a matter of tau congruencies, and coincidence isn't just random chance, which is why everyone keeps coming together again.

There is also the question of *why* Kuin is throwing the Chronoliths, but that is simpler to understand: They terrify the world and create a sense of vast expectation; the world knows it will be conquered; it awaits; and it is eager to get it over with. Cults arise (one of which sweeps up Warden's daughter). Armies march, each one led by a Kuin. And Sue struggles to master the technology of the Chronoliths in order to undo them, destroy them, destroy the building expectation.

Meanwhile, the Chronoliths keep coming, a rain of destruction and omen. Warden grows, becoming a better person than he was in Thailand. And the tale moves toward an inevitability of coincidence such as no one in SF has ever pulled off before.

Look for this one on award ballots.

I think we have all heard of the information explosion: There are today so many researchers, journalists, writers, artists, musicians, sculptors, and others generating stuff for us to read, study, absorb, watch, and listen to that no one has any hope of absorbing any significant fraction of the whole. This is famously true in academia, where it is among the factors that have driven the trend to specialization. It is true in science fiction—I read and review a lot, but I come nowhere near to covering it all. And it is true everywhere else as well.

Is this bad? In SF, it may have something to do with the death of the backlist which many writers bemoan (it used to be that a writer such as Terry Bisson would be able to see his novels in print for many years; today they vanish in weeks or months, bumped from the bookstore shelves to make room for newcomers). It may also have something to do with the difficulty new writers have in breaking into print, for older



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writers—even if their works don't stay in print—do stay active and develop readerships; we should not be too surprised if editors display a tendency to buy their new works instead of some newcomer's.

Is there anything we can do about it? Perhaps we could erect barriers to new entries. Professional certification of some sort would surely do the trick. Something like a doctor's MD degree—only the properly trained could be published. If you don't like that, how about a certification exam such as CPAs and lawyers (and doctors, for that matter) have to pass? You can't get out of the slush pile unless you can write a thousand-word essay on what was bad *and* good about E. E. "Doc" Smith's seminal works.

Or you could just sweep all the old crap out of the way. That's Terry Bisson's suggestion in **The Pickup Artist**. The background is a terrorist movement, "Les Eliminateurs," that firebombed galleries and museums, asking rhetorically "What would happen if one only ate and never eliminated?" Since most of the lost classics had been digitally reproduced, there was no real loss (right?), and it seemed quite natural for the movement to gather steam, especially after a certain reclusive billionaire and digital art reproducer bankrolled a conference to develop a framework to legitimate the process.

By the time of the story, that process is SOP. It even has a bureaucracy, one of whose members is Hank Shapiro, a "pickup artist" whose job it is to collect stray copies of books, paintings, prints, albums, and so on that have been declared dead and gone. He's not a bad fellow. He does his job well and responsibly. But one day he has to pick up an old Hank Williams album. Since he was named for the singer, he really wants to hear the music. He therefore embarks on a search for a record player that takes him from a speakeasy-equivalent, to the tunnels drug addicts have dug through a mountain of landfill searching for antiques, and through a couple of firefights. One of those firefights sticks him with the corpse of an Indian named Bob, who must be delivered to his brother Bob who refers them to another Bob, who. . . . A drug called Halflife lets Bob come to every so often to shout, "What? Me Dead!?" It also has kept Hank's new girlfriend, Henry, pregnant for the past nine years; when they run out of the drug, the baby is born wellnigh growed, smoking a cigar and doing a stand-up routine.

They wind up in Las Vegas, now a nation in its own right and a very suitable venue for a satisfactory denouement.

You get the idea. Bisson is a satirist of immense talent, and this time out he is at the top of his form.

Enjoy!

Last year, in *Jumping Off the Planet*, David Gerrold set thirteen-year-old Charles "Chigger" Dingillian and his two brothers—Douglas (older) and Stinky (younger)—off on an adventure. Earth's economy is collapsing, but the family manages a vacation up the Beanstalk. However, the family is a mess, and as soon as they reach Geosynchronous Station, Chigger goes to court to divorce the folks. He's just a kid, but Doug and his boyfriend Mickey can take charge: They'll all go to the Moon together and sign up for a ride on a colony ship. "Eat our dust, Mom and Pops. We're outa here. Sayonara!"

Unfortunately, there's Stinky's toy monkey. Something extremely valuable is embedded in its electronic memory—Pops was doing a spot of smuggling, you see—and as **Bouncing off the Moon** opens, the megacorps are after the kids. Fortunately, here's Alexei Krislov, the mad Lunar-Russian money-surfer, with an escape hatch. They're off to the Moon in a pod that has to land like a Mars Lander—bounce-down with airbags. After a bit of a trek, they learn that Alexei has his own schemes, which



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may not include helping them get on a colony ship to escape the whole mess.

Or maybe he too just wants the monkey? Maybe that's what Mickey is really after too?

Crushing disappointments are in store. People just aren't who they seem. But Chigger grows up more than a little, and even the monkey joins in the group hug at the end of the final courtroom drama.

The Heinlein juveniles drew at least one generation of young readers into SF. Gerrold has some of the same flavor and is bound to appeal to the same age group. If he can't have the same effect, that is surely because the kids have so much SF available on TV and film that print SF just can't seem as fresh and marvelous as it did to us when the world was new.

I had to struggle a bit to get through the first few pages of Susan Shwartz's **Second Chances**. Starship pilot Jim is "A survivor of Alliance's Fleet . . . an interloper on the civilian *Irian Jaya* since he'd boarded." At the moment he is steering one of "these civilian ridership." And it takes a while for Shwartz to untangle her presentation enough for the reader to figure out that the *Irian Jaya* is not a ridership. The ridership is more like a shuttle or workcraft carried by the much larger merchant ship.

Did the mention of "Alliance" make you think of C. J. Cherryh? It did me, too, as did the frenetically paced style. In fact, I thought Shwartz was trying to imitate Cherryh, and doing a poor job of it, too. Nor did it help later on when a rented gown turns up in a closet as having been bought.

But . . . I'm still recommending the book to you as a satisfying read. Shwartz has set her sights high, and she has come very close to hitting her mark.

Jim is on detached duty from Fleet to a civilian ship. The idea is to prove that Fleet is still valuable after the end of the war. Unfortunately, the civilian officers aren't happy about having a tin soldier aboard, not even after he leads a successful fight against pirates. They are so unhappy that when he is outside trying to get the ramscoops working again, they send a killer after him and pile into the captain's gig to abandon ship. After he kills the killer, he runs out of air and leaps toward the gig's airlock. The officers haul him in, thinking he is the killer.

In due time, when the *Irian Jaya* is rescued by erstwhile enemies, Jim is put on trial for abandoning his post. Since he did do that, and circumstances cannot extenuate, he takes his lumps and resists mightily when old friends offer him rehabilitation. He's tougher on himself than anyone else could possibly be.

Again and again, he finds a niche, does well, and abandons it as soon as anyone who knows his past shows up. Fortunately, some old friends are persistent; in due time, they find him a niche he can accept and not abandon even when he feels he has failed.

The tale is rife with other "second chances," but Jim is the central figure of the book and his pain and redemption are sufficient to justify your interest. Of the others, the most significant involve Caroline Marlow, who was frozen in an emergency pod at the beginning of the war and miraculously survived twenty years as a "shipsicle." She knew Jim when, she takes an interest, and she attracts the interest of an "eminence grise" who helps find Jim his final second chance and wants very much to give Marlow a second chance at life and love as well.

Embiid Publishing, based in Hawaii, is one of the new crop of digital publishing houses, and it has a nice list of titles, including Pratt's and de Camp's delightful *The Complete Compleat Enchanter* and a couple of our own Stanley Schmidt's titles. It even offers a monthly sampler of chapters from new releases, which is a nice way to make up for not



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being able to flip pages as in a "bricks and mortar" bookstore.

One recent release is Sharon Lee's and Steve Miller's **Changeling**, a novella set in their popular Liaden Universe. Liaden society is clan-based, with each clan specializing in a particular activity. Clan Obrelt, for instance, is a clan of shopkeepers. In the way of such things, however, some of a clan's kids have other talents. Obrelt's Ren Zel dea'Judan turned out to be a starship pilot, and once he had been expensively trained, a very good one. Then one day his clan leaders tell him they have arranged a nice upscale match for him, a young woman from a clan of pilots. Unfortunately, the young lady is headstrong, and when they take a flight together she crashes their ship and dies.

Her clan is furious. No matter that the blame was hers. They want reparations, and they get them. Ren Zel is disowned by his clan, forced to fly for Terrans. He does well, of course, but in due time his enemies step in again. Fortunately, a Master Pilot of Clan Korval has just arrived to investigate injustice and is able to step in at the proper moment.

And then? One is left with the feeling that this is but the opening episode in a larger adventure which Lee and Miller will bring us in the fullness of time. If so, it's a promising start.

Keep an eye out.

You know—and I know—that Vantage Press is a vanity press. They run little ads that say they are a New York publishing house and they're looking for authors. However, the criterion for publishability is much more the writer's willingness to write a check than any merits of the manuscript. To no one's surprise, the end result generally moulders away in basements, garages, and attics and very rarely appears in book review columns or bookstores.

But what the heck. Some books have too small a potential market to interest commercial publishers. Even the small presses may not offer them a niche. And if the author insists, we get . . . **Hey, It Could Happen! A Reader's Guide to the Years 2000 through 2099.** Mark L. Ford has taken notes on a great deal of science fiction, particularly on the various things SF authors have said will someday happen, and compiled a timeline. For instance, on March 3, 2008, Earth's first starship will launch (according to Alan Nourse). Two months later, we're at the edge of the universe (the film *Timemaster*), and in June a fleet of flying saucers arrives to take over Earth (May, *The Metaconcert*). It's thus a bit of a jumble, a mass of impossible conjunctions, and a bemusement for the masses. But if you're a fan, how can you not get a giggle out of this portrait of your favorite genre?

And if you're a writer, it could be a fun challenge to pick a year and come up with a plot that would make all the events Ford lists fit sensibly together.

Hmmm . . . ■

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# BRASS TACKS

Dear Dr. Schmidt,

Geoffrey Landis' "Case for Life on Mars" science-fact feature in the May 2001 *Analog* is the perfect excuse to explore some questions that I've had for a number of years.

I seem to recall that Carl Sagan often mentioned "Mars Jars" experiments, where different kinds of terrestrial life were placed in a simulated Martian environment to see if and how it could survive.

I assume that most of these experiments could be refined because we have more knowledge of Mars now then we did a decade ago. Have these experiments been repeated with our updated information from the Martian meteorites and recent probes?

Also, I wonder if anyone has thought to put earthly life inside an "Earth Jar," and, very gradually, change this environment into a Martian one and allow the life to adapt, by natural selection, over many generations.

This would be impractical for any living thing that has a long life cycle, but many bacteria can reproduce every fifteen minutes. We have seen bacteria breed themselves into antibiotic resistance over a period of only a few weeks.

It seems to me that extremophile bacteria could be placed within an artificial terrestrial environment which is gradually changed into a Martian environment, and that these artificial Martian microbes might give us a better idea of what to look for on Mars.

There is precedent. Parallel evolution has occurred many times here on Earth, where unrelated animals have the same appearance and behavior because of a similar environment (many examples can be found in Australian fauna).

I would like to know if such experiments have been done, and if anyone has ever actually succeeded in creating specially bred microbes that could survive on Mars.

It might have been interesting to read Landis' position on these ideas.

Kevin Levites

*The author replies. . . .*

You're quite right that the question of whether Earth organisms can survive—or could be bred to survive—on Mars is an extremely interesting one. Prof. Timothy Kral, working at the University of Arkansas, has been investigating growth of methanogens in Mars-simulant soil, although not at Mars temperatures. Methanogens are members of the Archaea, related to (but a different genus from) the halobacteria I discussed in the article. I haven't heard of the idea of starting with Earth conditions and then gradually changing to Mars conditions in an attempt to stimulate natural selection, but it sounds like an excellent experiment to me!

Geoffrey A. Landis

Dear Dr. Schmidt,

*Analog* publishes science fiction and science fact, and once in a while it is hard to tell which I'm reading. J.R. Dunn wrote an interesting review of historical weather patterns (*Analog*, Dec 2000) and came to conclusions that one contributor to the June 2001 Brass Tacks attributed to a "tiny minority" of the "scientific establishment."

Dunn responded by citing the Oregon



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Petition Project, which has been signed by 17,000 people Dunn identifies as "nearly one-fifth the working scientists in this country." The original article was interesting and factual, but this particular claim is fiction. Dunn uses this bit of nonsense to refute the assertion that very few scientists disbelieve the scientific party line.

First, 17,000 is hardly one-fifth of the working scientists, unless you define a relatively narrow range of technical people as "working scientists." That would make some sense; surely a petition like this would carry more weight if signed by people actually knowledgeable in closely related fields. I've examined the petition and its signers and they are anything but.

A quick scan of the list of names reveals immediately that about half have no advanced degrees. Of the "Doctors," many are just that: medical doctors. Some are dentists. A few are veterinarians. Are these the people you would expect to be in that narrowly defined set of specialists who might know what they are talking about?

It gets worse. I surveyed all the articles published in a three-month span of the journal *Science* and collected the names of authors of papers on atmospheric science, climate, and closely related fields—but not directly involved with greenhouse effects. I omitted those who did not work in the United States, leaving fifty distinct names. I searched the petition to see how many of these people had signed the petition.

Dunn said one-fifth of the working scientists? Then there should have been approximately ten of these people on the list. In fact, not a single one of them was on the list. Dunn's claim is in fact, fiction.

It is worth adding, that the petition has been organized by the Oregon Institute of Science and Medicine (www.oism.org), which is a very small organization that does do some good medical science, but also promotes issues like home schooling and survivalist causes. They sell K-12 curriculum materials that lack books written after about 1920. I guess not much has happened since then.

The political intent of the petition is made crystal clear by the site's introduction which says: "This is the website that knocks the wind out of the enviro's sails." [sic] Global warming is not simply a complex and undetermined issue but "a lie with no scientific basis whatsoever."

The Oregon Petition Project generates heat but little light. Dunn's credibility sags when he relies upon a source like this.

Gary Fostel
Portage, MI

Dear Dr. Schmidt,

In response to the debate around Mr. J.R. Dunn's article on global warming, I should like to chip in with my few cents worth of opinion as an archaeologist. What has been said on global warming has come mostly from people in the "hard" sciences, but as some have asked for a historical perspective (which really has been lacking), there are a few points to be considered. The favorable conditions during the Viking Age that Dunn mentioned do not represent the highest temperatures that have been reached after the last ice age, though they were good enough for the Vikings to reach Iceland, Greenland and Vinland (for an account of the Norse settlement at L'Anse Aux Meadows, see e.g. the article by Anne Stine Ingstad in *Acta Archaeologica*, Vol. XLI, pp. 109-154. Copenhagen 1970). 6000 years ago, during what in Europe is called the "Alleröd maximum," temperatures averaged 6 degrees C warmer than today, and deciduous forests covered most of what is now the Nordic countries in the Taiga belt (of coniferous forests). That temperatures were 6 degrees warmer in Northern Europe does not mean that they were that much higher globally, of course, as



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warming trends usually are felt more by higher latitudes, as has already been mentioned. Skeletons belonging to this period show that the height of an average male in Denmark during this time was over 180 cm (close to 6 feet, average, mind you!) a height that wasn't reached again until the late 20th century in Northern Europe. Even the Vikings were, on average, less than 180 cm tall. These people weren't suffering from the warmth—they were thriving!

Even people in the scientific community sometimes lose their heads and join the herd, but there remains the opportunity to step back, and scrutinize the actual evidence of climate change, as opposed to computer models. There is a tendency today to overvalue the effect of the human race on the earth, which has seen races, species and phyla come and go, and will see us go in our turn some day.

Thank you for the use of the soapbox,

Tryggve Gestrin
Finland

Dear Stan,

The collection of letters anent the Dunn defense of global warming (it isn't happening, it's happened before, it's not our fault) really turns me off. With the exception of Mia Molvray's, of course. I never realized that SF fans were that dumb. Or did you just pick the extreme to print?

What rather makes me burst out laughing is Dunn's defense, at the end, where he says solemnly that 17,000 signatures represent nearly a fifth of the "working scientists" in this country. What ever happens to the roughly quarter million graduates with science degrees last year? And the year before? Are they all out of 'work'?

And what makes a "scientist" particularly expert in climatology? Yes, I'll admit he's apt to be slightly better than the "non-scientist," statistically. But the people best situated to judge the climatological evidence . . . are climatologists. Not biochemists, computer theorists, etc.

Warren Rayle

*The author replies. . . .*

They don't get much more incidental than this. "Working scientist" speaks for itself : a scientist working on research in his own discipline; not in administration, not in teaching, not for the Sierra Club, not for Yellow Cab. As for percentages of climatic scientists, Mr. Rayle can amuse himself further by checking on how many climatologists support the warming thesis. An interesting start can be made with the membership of the Intergovernmental Panel on Climate Change.

There's not a single other statement of fact in this letter, something so symptomatic of the debate at large that it's senseless to take it any further. Me, I like facts:

•The atoll of Vanuatu, due to be swept away by greenhouse floods, has been reprieved by an inexplicable drop in water levels. (Ben Bova, please note.)

•The "melting" of Arctic ice that scared the *New York Times* has been demonstrated to be cyclical by Canadian scientist Greg Holloway, caused by shifting winds opening gaps in the ice cover from year to year.

•The UK's Met Office reported in *Geophysical Research Letters* that air and water temperatures are effectively decoupled, requiring that all warming estimates be cut by 40%.

•This spring, Mississippi barges arrived in St. Paul on the latest date on record, cut off by river ice.

•Last year was the wettest in Britain since 1766.

. . . and the same could be said of New Jersey, in the low 60s with rain for this last week of May. If it's coming, it's taking its time. I'm still waiting.

(My thanks to Tryggve Gestrin. Medieval Britons also topped six feet. Coincidence?)

J.R. Dunn ■



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# UPCOMING EVENTS Anthony Lewis

**23–25 November 2001**
LOSCON 28 (Los Angeles area SF conference) at Hilton Burbank Airport, Burbank, CA. Guest of Honor—Patricia C. Wrede; Artist Guest of Honor—Chris Butler; Fan Guest of Honor—Lynn Gold. Registration—$40 until 31 October 2001; $45 at the door. Info: Loscon 28, 11513 Burbank Blvd., North Hollywood, CA 91601. Email: chair@loscon.org. URL: www.loscon.org/loscon/28.

**7–9 December 2001**
SMOFCON 19 (SF convention runners conference) at York, England. Info: Kim Campbell, 69 Lincoln St., Leeman Road, York YO26 4YP, UK. Email: kcampbell@cix.co.uk

**18–20 January 2002**
ARISIA '02 (Boston speculative media conference) at Boston Park Plaza Hotel and Towers, Boston, MA. Guest of Honor—Katherine Kurtz; Artist Guest of Honor—Tristan Alexander; Fan Guest of Honor—Eugene Heller. Info: Arisia, Inc., 1 Kendall Square, PMB 322, Building 600, Cambridge, MA 02139. URL: www.arisia.org

**18–20 January 2002**
CHATTACON 27 (Tennessee SF conference) at Clarion Hotel, Chattanooga, TN. Guest of Honor—Melanie Rawn; Artist Guest—Robert Daniels; Special Guest—Jack McDevitt; TM—Charles Grant. Registration—$30 until 31 December 2001, $40 thereafter. Info: Chattacon 27, Box 23908, Chattanooga, TN 36422-3908. Email: info@chattacon.org; URL: www.chattacon.org

**18–20 January 2002**
CONFUSION 2002 (Ann Arbor area SF conference) at Van Dyke Park Suites, Warren, MI. Guest of Honor—George R.R. Martin; Artist Guest of Honor—Pete Abrams; Science Guest of Honor—Guy Consolmagno; Fan Guest of Honor—Heather Alexander; TM—Sharon Myers Shaw. Info: ConFusion, Box 8284, Ann Arbor, MI 48107. Email: confusion@stilyagi.org; URL: www.stilyagi.org/cons/confusion.html

**29 August–2 September 2002**
CONJOSE (60th World Science Fiction Convention) at Convention Center, et al., San Jose, CA. Guests of Honor—Vernor Vinge, David A. Cherry, Bjo & John Trimble; TM—Tad Williams. Registration—$140 until 10 July 2001, more thereafter. [These are the latest rates posted on the Internet as of the time this column went to press.] This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition—the works. Info: ConJose, Box 61363, Sunnyvale, CA 94088-1363. Email: info@conjose.org, URL: www.conjose.org

*Convention attendees: When calling conventions for information, do not call collect and do not call too late in the evening. It is best to include a S.A.S.E. when requesting information; include an IRC if the convention is in a different country.* ■



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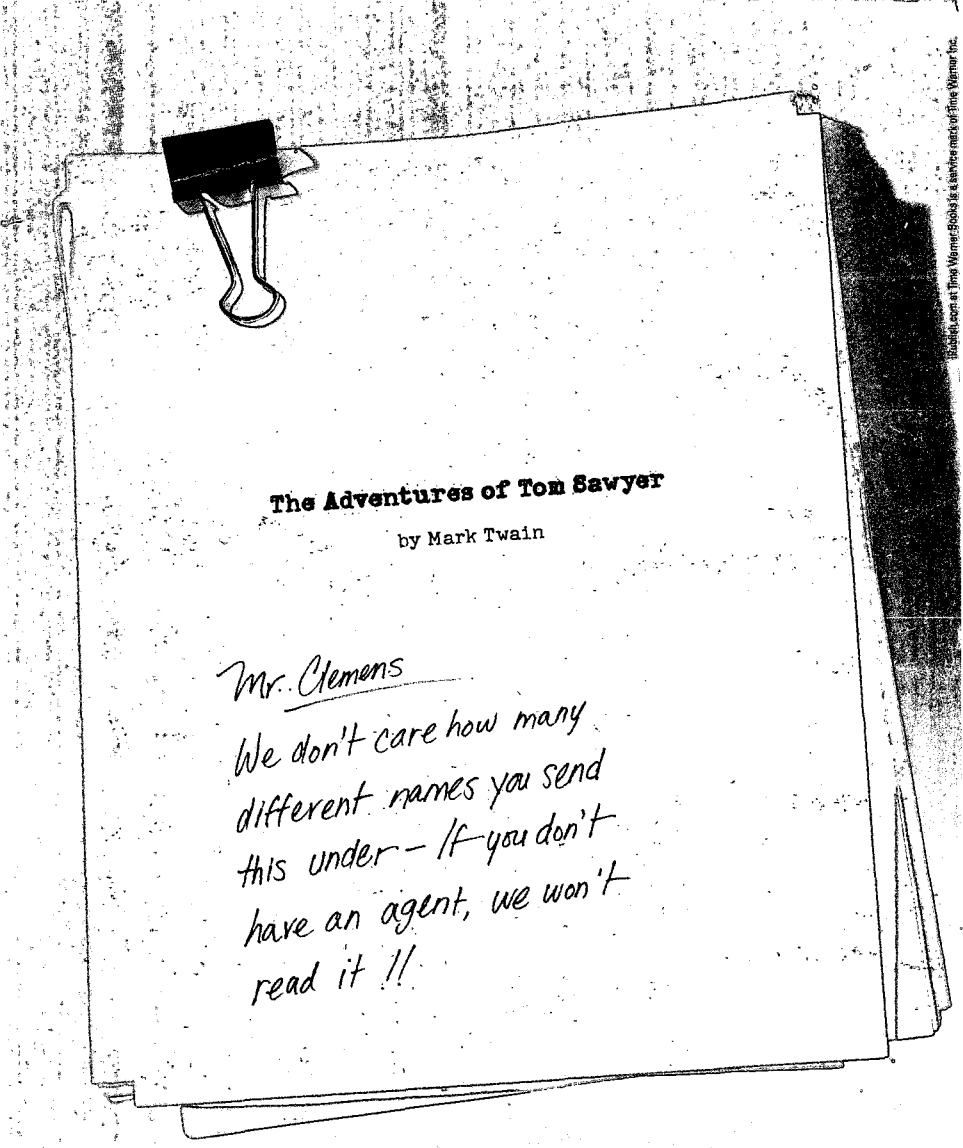
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